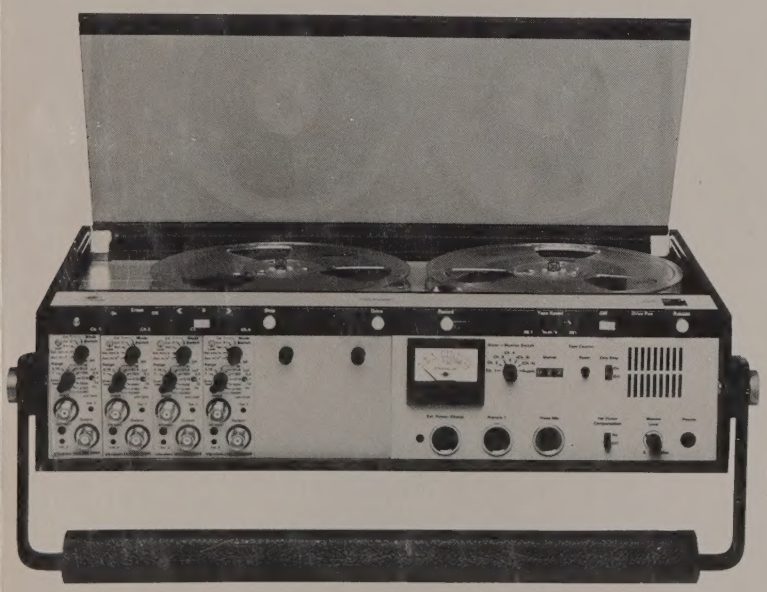
7007

Instruction Manual

Tape Recorder Type 7007



A completely self-contained, portable instrumentation class tape recorder for field and laboratory use. It incorporates four plug-in Vibration Units ZM 0060 which are especially designed for wide band FM recording of a wide variety of vibration signals in the frequency range from 0,3 Hz to 20 kHz. Each unit has a charge amplifier input which facilitates direct coupling of piezoelectric vibration measurement transducers without need of external preamplifiers. Provision is made for recording either vibration acceleration or velocity and the Input Range may be switched in accurate 10 dB steps to provide output ratings between 1 and 10 000 mV/vibration unit.

For recording of voltage and acoustic signals the Vibration Units may be replaced by one or more Direct and FM Units ZE 0299 and ZM 0053. Also a Two Channel Compander ZM 0054 may be used alongside any two of the units to permit unattended recording of non stationary signals with dynamic range of 70 dB. For powering the Recorder either a plug-in battery pack or optional mains adaptor and battery charger may be employed.

B K Brüel & Kjær

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TAPE RECORDER
TYPE 7007

From serial no. 1132341

Revision June 1985

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Portable Instrumentation Tape Recorders

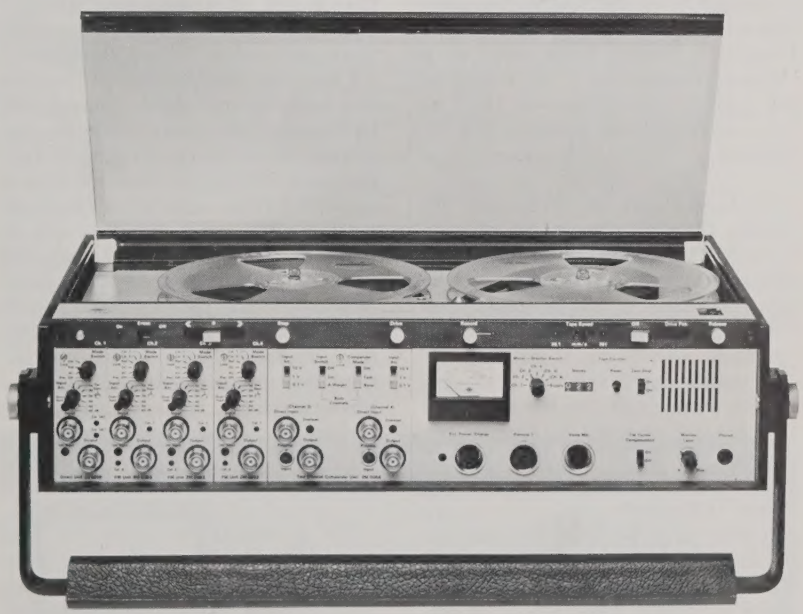
USES:

- Field and laboratory recording of vibration and sound data etc., covering a frequency range from DC to 60 kHz
- Collection, storage and reproduction of data for detailed laboratory investigation and frequency analysis
- Time and frequency transformations
- Tape loop repetition of short duration events for frequency analysis

FEATURES:

- Easy to carry instrumentation class tape recorders for out-and-about field and laboratory use
- Easily interchangeable plug-in units for any combination of 4 IRIG FM and Direct record channels
- FM recording from DC up to 20 kHz at 15 in/s
- Direct recording from 4 Hz at 1,5 in/s up to 60 kHz at 15 in/s
- Compander Unit for unattended recording of non stationary signals with dynamic range >70 dB
- Direct, plus microphone and accelerometer pre-amplifier inputs.
- Crystal controlled, differential tape drive for low-flutter bench and mobile use
- Post record flutter compensation reduces effect of external vibrational disturbances
- Fully enclosed tape compartment accepts 7 inch tape spools and B&K tape loop cassettes
- Plug-in rechargeable battery pack, plus optional AC mains adaptor and charger

The B&K Types 7005, 7006 and 7007 are three wide-band instrumentation recorders for multi-channel FM and Direct tape recording to IRIG standards. They are low-weight, attache-case size instruments which are especially designed for recording of sound, vibration and other signals in the field as well as withstand the rigors of mobile use. Along with the choice of operation from a plug-in battery pack or AC mains adaptor (option), they accept easily interchangeable plug-in units for any combination of 4-channel FM and Direct recording. Despite their small size and portability they have a performance exceeding that of many recorders in the heavy-weight laboratory class and therefore are well suited for laboratory applications including recording and reproduction of data for analysis purposes.



General

A detailed description of the Bruel & Kjær Tape Recorders, including associated accessories, is given on the following pages. Type 7005 consists of a tape transport and monitor mainframe fitted with 1 Direct and 3 FM Record-Reproduce Units plus a Two Channel Compander, while Type 7006 is the mainframe only with the option of ordering any combination of FM and Direct Units with or without the Two Channel Compander Unit. In addition an optional FM Unit which is especially designed for recording and reproduction of vibration signals is available for use with the Recorders. Type 7007 Recorder is the tape transport and monitor mainframe fitted with four of these Vibration Units and no Compander Unit.

Fig. 1. General view of Portable Tape Recorder Type 7005 plus associated plug-in units, battery pack etc.

Mainframe

Low-weight, compact size and robust construction are all important considerations in the design of the B & K Tape Recorders. The Recorders utilize the same basic mainframe which has a strong aluminium chassis and houses the tape transport, tape head assemblies plus control and monitor circuitry. At the front of the mainframe there is space to insert up to 4 Record - Reproduce Units and a Two Channel Compander Unit, whilst at the rear a plug-in Battery Pack or optional AC Mains Adaptor may be inserted.

All controls of the Recorders, including their tape deck, are recessed so that the outer edges of the mainframe protect them from damage. The tape deck has a hinged plastic lid which may be kept closed even when operating with 18 cm (7 in) diameter tape spools fitted and for extra protection when using the Recorders for field use, for example, a Leather Case can be fitted (see Accessories).

Tape Transport

A close-up of the Tape Transport of the Recorders is shown in Fig. 2. It is especially constructed to allow horizontal or vertical operation of the Recorders and is built up on a rigid base so that the accurate alignment of the tape guide and tape head assemblies etc., is maintained throughout the life time of the Recorders.

The heart of the Tape Transport is a low-inertia drive motor. This features electronic control by means of a sensitive servo amplifier system and for tape speed settings of 38,1 and 381 mm/s (i.e. 1,5 and 15 in/s) accurate to within $\pm 0{,}25\%$, is phase-locked to a reference frequency derived from an internal crystal oscillator (see Fig. 3). Two LEDs mounted by the TAPE SPEED switch on the front panel show which setting is selected plus inform when the Recorders have locked onto the correct speed.

As indicated in Table 1, the Recorders have low inherent flutter. In order that accurate and stable operation can be depended upon even when they are subject to external motional disturbances, a differential capstan drive is employed. This consists of two capstans, mounted one on either side of the record-reproduce head assembly (see Fig. 2) which accurately guide plus isolate the tape in contact with the heads from spool feed irregularities. Moreover tape speed fluctuations due to movement and vibration when carrying or transporting the Recorders are largely eliminated on account of the differential action of the capstans.

For a further reduction in tape speed disturbances a "Flutter Compensation" mode may be selected. This is operative with the FM Units of the Recorders only and records a fixed frequency reference on tape via channel 2. On playback of the reference its instantaneous frequency is used to automatically correct the reproduce amplitude of data recorded with the other FM channels and reduces the effects of recorded flutter due to external motion and vibration by as much as 35 dB at frequencies up to 500 Hz.

Tape Speed	Cumulative Peak-Peak (IRIG 106.66 - 77)	Weighted Flutter (DIN 45 507)
38,1 mm/s	< 0,7% (0,5 to 313 Hz)	< 0,1%
381 mm/s	< 0,5% (0,5 Hz to 2,5 kHz)	< 0,06%

Table 1. Typical flutter values with the 7005, 7006 and 7007

Tape Drive Controls

The tape drive controls are simple push-button and slider types. These permit convenient single-handed operation of the Recorders and where relevant are interlocked to protect against accidental erasure of data. For remote operation there is a separate REMOTE socket whereby the Record - Play and Start - Stop functions of the Recorders may be actuated using a simple external switch arrangement.

In addition to Tape Speed settings of 38,1 and 381 mm/s, Fast Wind and Rewind functions are provided. These are capable of winding or rewinding one complete 18 cm (7 in) diameter spool containing 690 metres of recording tape in about 7 minutes. To eliminate tape spill as well as unnecessary power drain with the battery pack, an auto-stop function is included which is activated by a small proximity detector (infrared type) mounted opposite the erase head (see Fig. 2).

Tape Indexing and Marking

For tape indexing, the Recorders are furnished with a 3-digit counter. This counts directly in metres and for fast location of the start of recorded

data on rewind may be set to automatically stop the tape drive at zero count.

A second means of locating recorded data is with aid of the marker facility. This is triggered by the passage of optically reflective marking or splicing tape in front of the proximity detector and depending on the length of the mark or slice, may be used to actuate the auto-stop function and/or generate a marker pulse. The main use of the marker, however, is in synchronization of external equipment when tape loop recorded data is frequency analyzed. See "Examples of Use".

Monitor Facilities

For monitoring of record level both before and during recording, as well as on playback, the Recorders incorporate a sensitive moving-coil meter. This may be switched to provide a separate indication for each channel in turn and is graduated from –20 to + 3 dB with 0 dB corresponding to the nominal record level. The meter is equipped with a Max. Peak Detector which responds to negative as well as positive signal peaks and provides an accurate record level indication at all frequencies in the recording range.

Supplementing the meter is a built-in loudspeaker. This has its own volume control and if required may be switched out by a pair of external phones (not provided) to permit monitoring in noisy environments.

For recording comments of measurement and tape identities the Voice Microphone shown in Fig. 1 is included. This makes use of a separate preamplifier circuit in the Recorders which for use as a voice channel is coupled to channel 1 when a switch on the microphone is actuated.

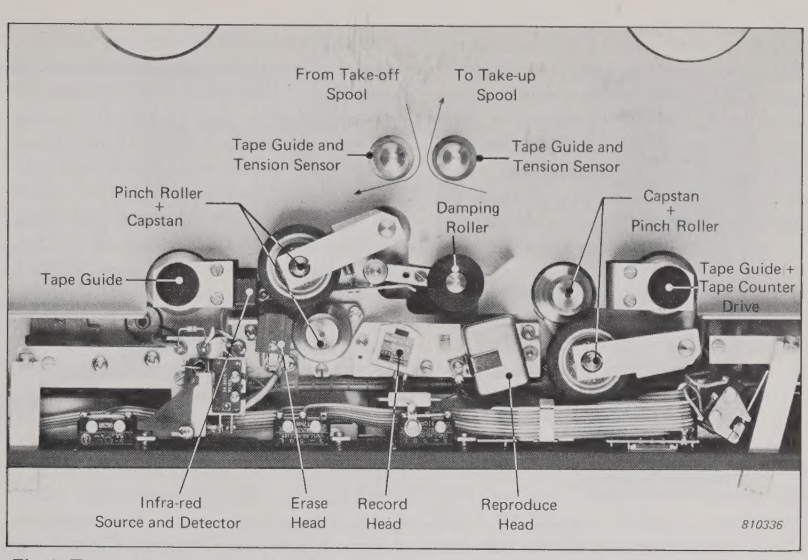


Fig. 2. Tape transport of the Recorders showing the differential capstan drive and record-reproduce head assemblies

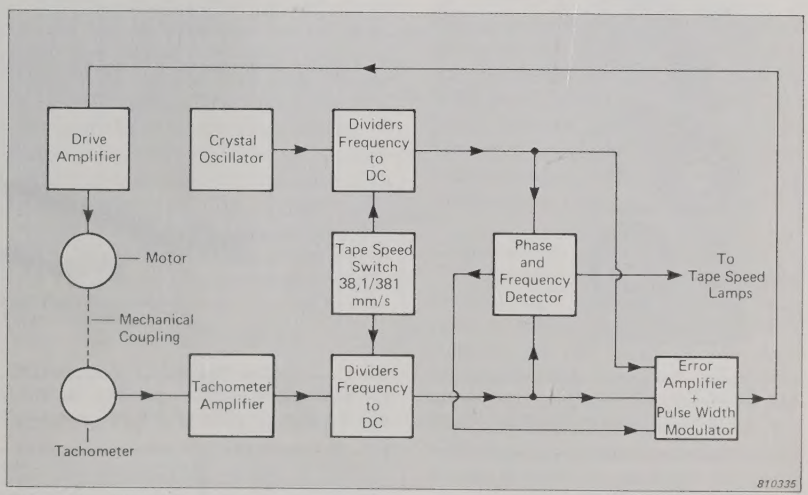


Fig. 3. Simplified block diagram of the drive motor servo system

Record–Reproduce Channels

As standard, Tape Recorder Type 7005 includes 1 Direct Unit ZE 0299 for channel 1, plus 3 FM Units ZM 0053 for channels 2, 3 and 4. These are designed to fulfil a wide range of sound, vibration and voltage signal recording needs and are pre-aligned plug-in units for easy interchangeability.

With Tape Recorder Type 7006 which is the recorder mainframe only, there is the option of ordering any

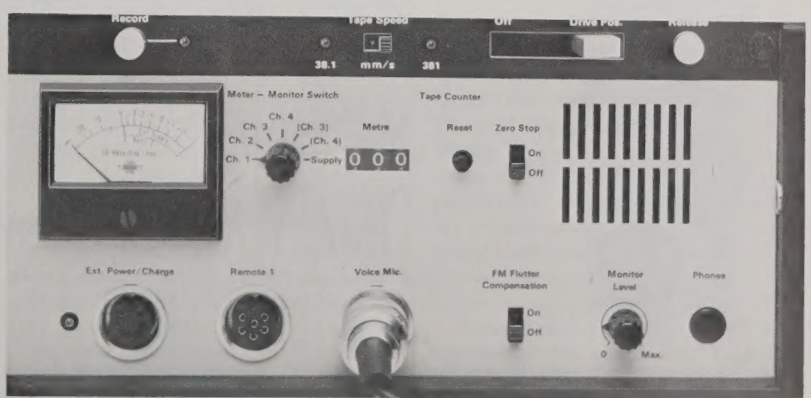
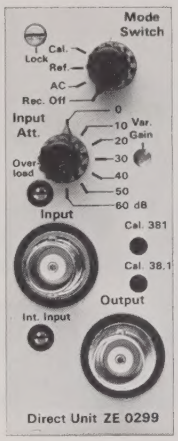


Fig. 4. Detail showing the front panel controls of the mainframe.



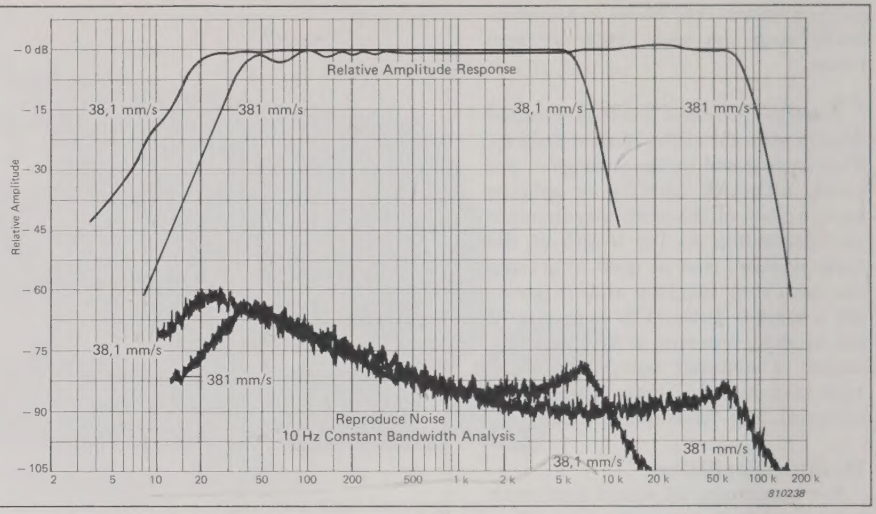
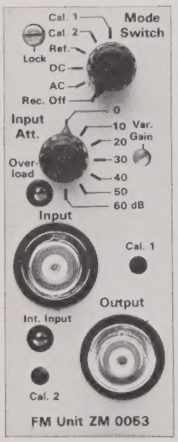


Fig. 5. Direct Unit ZE 0299 plus typical record-reproduce response obtained. The minimum signal-to-noise ratio is 42 dB (Lin) at 38,1 and 381 mm/s. Together with the Compander Unit ZM 0054 signals with dynamic range >70 dB (Lin) can be handled



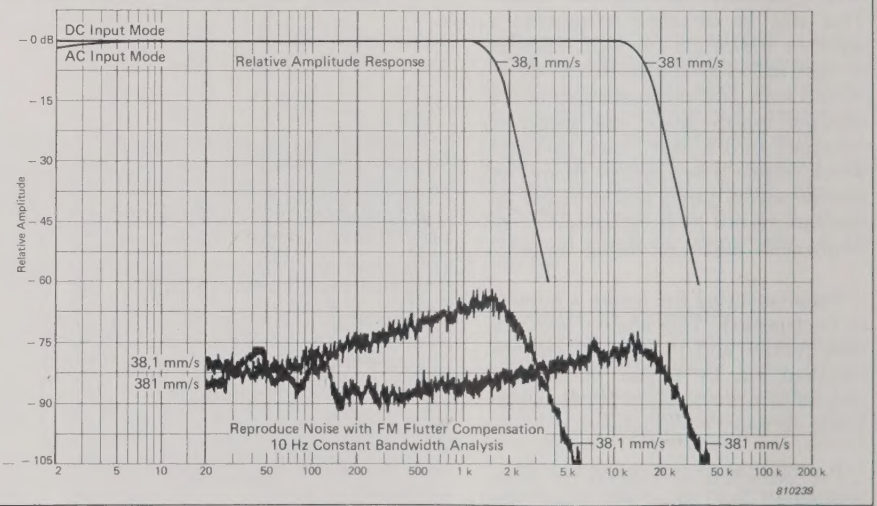
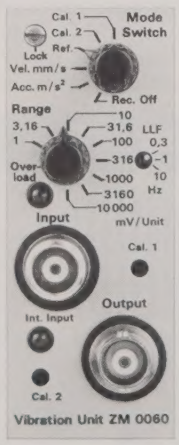


Fig. 6. FM Unit ZM 0053 plus typical record-reproduce response obtained. The minimum signal-to-noise ratio is 40 dB (Lin) at 38,1 mm/s and 44 dB (Lin) at 381 mm/s. Together with the Compander Unit ZM 0054 signals with dynamic range >70 dB (Lin) can be handled



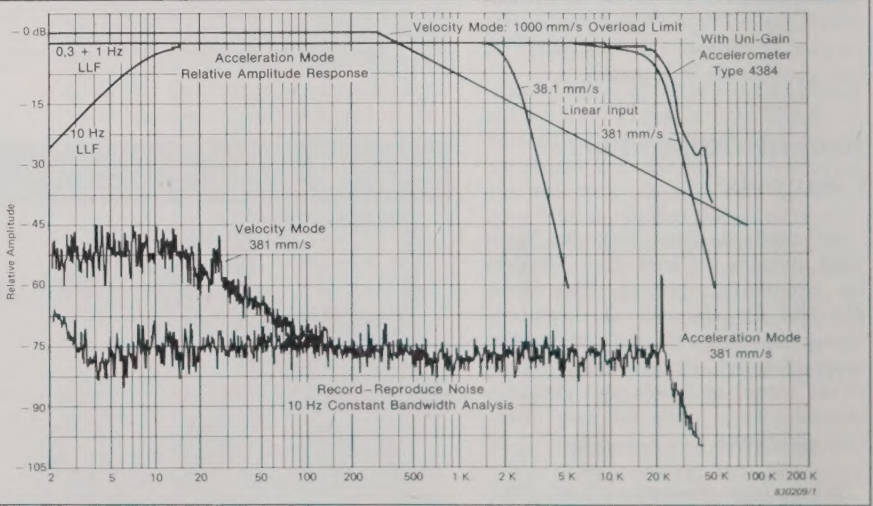


Fig. 7. Vibration Unit ZM 0060 plus typical record-reproduce response obtained. The minimum signal-to-noise ratio is 40 dB (Lin) at 38,1 mm/s and 381 mm/s

combination of up to 4 of the above units. Alternatively one or more channels of the 7006 (or for that matter the 7005), may be fitted with an FM Unit ZM 0060* which is specifically designed for recording of vibration signals.

Tape Recorder Type 7007 consists of the recorder mainframe fitted with four ZM 0060 Vibration Units as standard equipment. These units which facilitate both acceleration and velocity measurement are ideal for direct connection of piezoelectric accelerometers owing to the incorporation of a charge amplifier.

Direct and FM Units ZE 0299 and ZM 0053

These are shown in Figs. 5 and 6, and are intended for multipurpose recording of most analogue data including sound, vibration and voltage signals. The Direct Unit ZE 0299 utilizes the Intermediate Band Direct recorded technique laid down by the American IRIG (Inter-Range Instrumentation Group) Standards 106.66 to 106.77; while the FM Unit ZM 0053 utilizes the Wide Band (Group 1) FM technique of the same standards.

The Direct Unit ZE 0299 is well suited for recording of audio and high frequency signals, especially where audio reproduction and laboratory measurement of RMS signal levels and frequency analysis are of interest. As indicated in Fig. 5 it provides an overall record-reproduce response with ±3 dB low frequency limit of 20 Hz at a tape speed of 38,1 mm/s and an upper frequency limit of 60 kHz at 381 mm/s. Furthermore frequency components as low as 4 Hz may be recorded at a tape speed of 38,1 mm/s, however, for reproduction of these components a 1:10 frequency transformation must be made using the 381 mm/s tape speed for playback.

With the FM Unit ZM 0053 the overall record-reproduce response is as shown in Fig. 6. In this case the –1 dB upper frequency limit is 12,5 kHz at a tape speed of 381 mm/s and 1,25 kHz at 38,1 mm/s. The low frequency response on the other hand extends all the way down to DC and thus enables static and very low frequency signals to be recorded.

Other benefits of FM recording are particularly good low-frequency phase linearity, plus excellent amplitude stability independent of the magnetization and storage characteristics of the recording tape. It is thus ideal where faithful waveform preservation and high-accuracy reproduction of both Peak and RMS levels are important for laboratory measurements and analysis. Typical applications are recording of static and dynamic strain, mechanical vibration and shock, plus most acoustic signals including those containing infra-sound and transient components.

The controls of the FM and Direct Units are similar. Besides a Function Selector switch for selecting the appropriate channel input, output and calibration modes, each is equipped with a stepped attenuator and variable sensitivity adjustment enabling input signals levels between 31,6 mV and 31,6 V to be accommodated.

For warning of input levels in excess of the + 3 dB maximum record level, each unit has an "Overload" indicator LED. With the FM Unit both DC and 4 Hz-AC input coupling may be chosen and there is a voltage limiter to prevent overload disturbing the modulator and squelch circuits. Also both units feature an "Int. Input" LED which informs when they are coupled with the Compander Unit, Voice and-/or FM Flutter Compensation circuits of the Recorders.

Vibration Unit ZM 0060

The Vibration Unit ZM 0060 is shown in Fig. 7. It is intended for use with piezoelectric accelerometers and is a comprehensively equipped FM record-reproduce unit which is especially designed for recording a wide variety of vibration signals, including mechanical shock. Provision is made for recording either vibration acceleration or velocity and a charge amplifier is built in permitting local or remote use of accelerometers without their connecting cable influencing their calibrated sensitivity.

Signal conditioning with ZM 0060 is based on use of the B&K Uni-Gain Accelerometers Type 4371 and 4384. These have a factory calibrated sensitivity of 1 pC/ms^{-2} and depending on the Input Range setting chosen on the Vibration Unit enable vibration levels up to 1000 ms^{-2} to be recorded. Input Range settings are selectable in accurate 10 dB steps and to facilate easy determination of recorded vibration levels on playback are especially graduated from 1 to 10000 mV/vibration unit. If required other accelerometers may be used, including non Uni-Gain types, but in this case a correction factor must be applied or a reference vibration level recorded for evaluation of recorded levels.

The record technique employed by ZM 0060 is the same as that used with the FM Unit ZM 0053 and yields the same high-accuracy reproduction of signals. Its overall response, however, is optimized for a –3 dB upper limiting frequency of 16 kHz at a tape speed of 381mm/s. This is obtained with the "ms^{-2}" acceleration mode (see Fig. 7 for "mms^{-1}" velocity mode limits) and with Accelerometer Type 4371 or 4384 connected is extended to approximately 20 kHz by the mounted resonance frequency of the accelerometer.

To permit reliable operation with Accelerometers which are exposed to temperature fluctuations, ZM 0060 is designed with a selectable –3 dB lower limiting frequency of 0,3; 1 and 10 Hz. With Accelerometers Types 4371 and 4384, however, the use of the 0,3 Hz setting is normally possible as these accelerometers already have a low temperature transient sensitivity.

Calibration

Calibration of the Recorders is easy to apply and exhibits excellent long-term stability. Screwdriver operated controls on the front of the units facilitate quick, accurate adjustment according to reference indications provided on the record level meter. For calibration of external equipment and determination of recorded levels on play back a 1 kHz sinusoidal reference signal can be switched-in which is derived from the internal crystal oscillator.

Two Channel Compander

In addition to the Direct and FM Units the 7005 includes the Two Channel Compander Unit ZM 0054 shown in Fig. 8. This is basically an automatic gain control and is ideal for unattended recording of non stationary signals where audio reproduction and broad-band measurement of recorded levels are of interest.

During recording the Compander compresses the signal level variations recorded on tape, whilst on playback it expands them, reinstating them in correct proportion to the original sig-

* When a Two Channel Compander Unit ZM 0054 is included a maximum of two Vibration Units ZM 0060 together with two Direct Units ZE 0299 or one FM Unit ZM 0053 can be used on account of the maximum power consumption of the units.

nal. In this way non stationary signals with dynamic range of over 70 dB may be recorded and reproduced without actually altering the signal-to-noise ratio or 4-channel record-reproduce capability of the Recorder.

The Compander operates in conjunction with channels 3 and 4, and when switched in is internally coupled with the appropriate plug-in record-reproduce units of these channels. As shown in Fig. 8 it is furnished with separate input and output sockets which are used in place of those on the FM, Direct or Vibration Units. Both "Direct" and "Preamp." voltage inputs are provided to each channel, the latter permitting direct connection of two ½-inch Microphone Preamplifiers Type 2642 for sound recording. Besides powering ext. preamplifiers, the "Preamp." inputs may be switched to provide 0, 28 or 200 V polarization needed for operation of different types of condenser microphone.

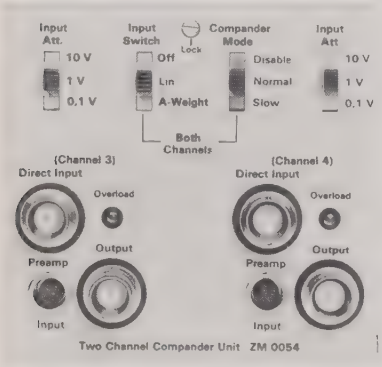


Fig. 8. The Two Channel Compander Unit ZM 0054

Also provided with the Compander are "Lin" and "A"-weight input modes. The "A"-weight input response is the same as used with precision sound level meters and complies with Type 1 characteristics of IEC 651, while the "Lin" response is from 10 Hz up to 60 kHz. However, the overall record-reproduce response depends on the tape speed setting and the FM, Direct or Vibration Units used with the Compander. See Specifications.

Accessories

Power Supplies

All three tape recorders include a plug-in Battery Pack, but can be powered just as conveniently by an external source. The Battery Pack consists of a Battery Box ZG 0146 plus six 1,2 V rechargeable Ni-Cd Batteries QB 0008, and is capable of providing between 3 to 5 hours of continuous operation with the Recorders. If a longer operating time is required, then a spare Battery Pack may be obtained or an external 6,5 to 15 V DC source such as a car battery employed.

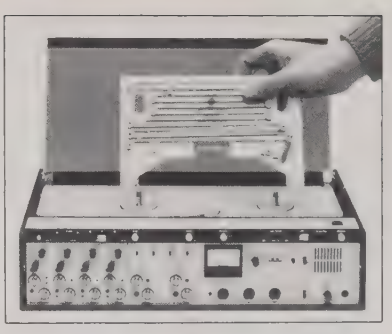


Fig. 9. Fitment of Tape Loop Cassette UD 0035 to one of the Recorders

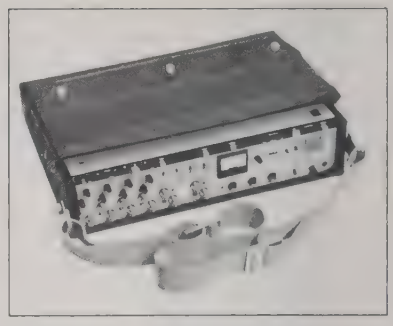


Fig. 10. One of the Recorders with Leather Case and Shoulder Strap fitted

For mains operation, the Battery Pack may be replaced by a plug-in Power Supply ZG 0199 (earlier Type 2808). Alternatively, this may be used externally for powering the Recorders, whilst charging the Battery Pack in their supply compartment. For charging Battery Packs without the Recorders present, ZG 0199 may be coupled with an separate Charge Adaptor AQ 0157. This will free the Recorders for field use, whilst spare Battery Packs are charged in the laboratory.

Recording Tape and Cassettes

The Recorders are supplied with two 18 cm spools one of which contains 690 m of instrumentation grade tape (Ampex 797 or equivalent). This is suitable both for FM and Direct recording and with a tape speed of 38,1 mm/s provides a maximum of 5 hours continuous recording.

Also supplied is a B&K Tape Loop Cassette UD 0035. This is designed to permit repetitive playback of short duration signals for frequency analysis purposes, and as shown in Fig. 9 conveniently fits over the drive hubs of the Recorders in place of tape spools. To save threading tape loops by hand the cassette comes preloaded with a 2,5 m long tape loop, however, other loops may be fitted if desired.

Transport and Rack Mounting

To suit different needs, the Recorders are available in A, C and F models. Model A is the basic Recorder with shoulder strap and foam-grip carrying handle, whilst model C is the same as model A, but with the addition of an adaptor panel for mounting the Recorders on the front of a 19 inch instrumentation rack. With model F the leather case in Fig. 10 is included which has snap fastenings to allow easy access to the controls and tape deck of the Recorders.

Examples of Use

One of the major applications of the B&K Tape Recorders is in recording of field data for laboratory processing. This is especially of benefit where data from a number of different locations must be collected. Generally bulk processing of tape recorded signals using laboratory instrumentation is faster and permits more detailed and comprehensive measurement and analysis than can actually be carried out on site.

Examples of such use are in architectural acoustics where the acoustical response of rooms, halls, auditoriums and theatres may be recorded for laboratory investigation; and in recording of machine vibration for preventive maintenance purposes where subsequent frequency analysis of recorded vibration may be used to pin-point sources of machine wear and malfunction long before breakdown occurs.

The choice 38,1 and 381 mm/s tape speeds with the Recorders permits signals to be transformed up or down in frequency by a factor of 10, thus enabling very low or high frequency components to be brought in range of measurement and analysis equipment. For frequency analysis only a short sample of signals need be recorded as these can be transformed into a repetitive signal utilizing the tape loop cassette. Furthermore when using a B&K Filter Set Type 1617 or 1618 for analysis, the marker output of the Recorders may be used to automatically step the filter centre frequency on

each pass of the loop, as well as trigger the Gauss Impulse Multiplier Type 5623 which is useful for splice muting and spectrum strobing of the signal.

Fig. 11. Field use of Tape Recorder Type 7005

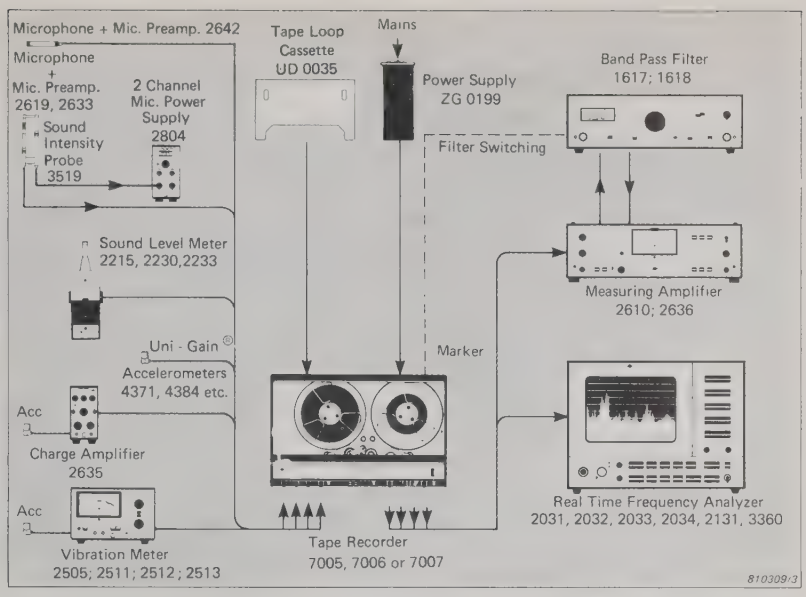


Fig. 12. Equipment for field recording and laboratory analysis of sound and vibration data

Common Specifications 7005, 7006 and 7007

RECORDING TAPE:
6,35 mm (0,25 in), instrumentation grade magnetic tape (Ampex 797 or eqivalent) on B&K Tape Loop Cassettes UD 0035 or 180 mm (7 in) diameter spools with cine-hub

CHANNELS /TRACKS: 4

RECORD-REPRODUCE HEADS:
Separate 4-track record-reproduce heads for any combination of 4-channel FM and Direct recording. Track geometry compatible with ISO 3413 - 1975

TAPE ERASURE
Electrically interlocked full-track erase with warning light indication. Erase attenuation better than 70 dB at 1000 Hz

RECORD LEVEL METER:
Sensitive moving-coil type, indicating Max. Peak record - reproduce level (-20 to + 3 dB), plus internal or external supply status

AUDIO MONITOR:
Built-in loudspeaker with volume control, plus standard jack socket for connection of external phones. Nominal output level and impedance is 2 V and 15 Ω respectively

MEMO ANNOUNCEMENTS:
Voice Microphone MM 0021 supplied for recording comments via separate input to channel 1

TAPE TRANSPORT:
High-stability differential tape drive with servo controlled motor phase locked to internal crystal reference oscillator

TAPE SPEEDS - FLUTTER (DIN 45-507):
38,1 mm/s (1,5 in/s): <0,1%
381 mm/s (15 in): <0,06%

FLUTTER COMPENSATION (FM ONLY):
Electronic compensation via selectable on-tape reference. Reduces effect of external motion or vibration induced flutter on reproduce levels by 35 dB (DC to 500 Hz) at 381 mm/s

RECORD, START/STOP TIMES ETC.:
Record - Play Time:
38,1 mm/s: 5 hours
381 mm/s: 30 minutes
for 690 m (2300 ft) of recording tape on 18 cm diameter spools

Start/Stop Times:
38,1 mm/s: ~1 s/1 s respectively
381 mm/s: ~3 s/1 s respectively
depending on battery status

Fast Forward Wind - Rewind Time:
~7 minutes for 690 m of recording tape. ~2 s stop time. Depend on battery status

TAPE COUNTER
3-digit counter indicating tape length in metres. Selectable "Zero-Stop" of tape drive aids fast location of data on forward wind or rewind

AUTO-STOP AND TAPE MARKING:
Photoelectric proximity detector. The marker function is triggered by optically reflective splicing tape and generates electrical pulse which may be used for remote switching of the B&K Band Pass Filters Types 1617 and 1618 for example

REMOTE CONTROL:
Record - Play, Start - Stop control lines available at 6-pin DIN socket

ENVIRONMENTAL CONDITIONS:
Temp. Range: -10 to + 50°C (+14 to +122°F)
Humidity: up to 90% RH (non condensing)

POWER REQUIREMENTS:
Plug-in Battery Pack: Six 1,2 V rechargeable Ni-Cd Cells QB 0008 (IEC R20) included, giving 3 to 5 hours continuous operation
AC Mains Adaptor/Charger: Plug-in Power Supply ZG 0199 available. Recharge time approximately 14 hours
Ext. Source: 6,5 to 15 V (1,2 A nom. 2,5 A max.) DC for powering the Recorders. 12 V (400 mA nom.) DC for recharging their plug-in Battery Pack.

DIMENSIONS:
Height: 102 mm (4,0 in)
Width: 430 mm (16,9 in)
Depth: 274 mm (10,8 in)

WEIGHT: 8,8 kg (19.4 lbs) Incl. Battery Pack

ACCESSORIES INCLUDED WITH 7005:

1 × Direct (Rec-Repro) Unit	ZE 0299
3 × FM (Rec-Repro) Unit	ZM 0053
1 × Two Channel Compander	ZM 0054
1 × Empty 18 cm Tape Spool	LS 0041
1 × 690 m of Inst. Tape	QR 1003
1 × Tape Loop Cassette	UD 0035
1 × Voice Microphone	MM 0021
1 × Plug-in Battery Box	ZG 0146
6 × 1,2 V Ni-Cd Cells	QB 0008
8 × BNC Plugs	JP 0035
1 × 6-pin Plug	JP 0600
1 × 8-pin Plug	JP 0802
1 × 7-pin Power Cable	AQ 0035
1 × Sens. Adj. Tool	QA 0070
1 × Carrying Handle	DH 0402
1 × Shoulder Strap	DH 0427

ACCESSORIES INCLUDED WITH 7006
Same as 7005 but with 4 × UA 0625 and 1 × UA 0626 Blank Panels instead of the Direct, FM and Two Channel Compander Units which must be ordered separately for the 7006

ACCESSORIES INCLUDED WITH 7007
Same as 7005 but with 4 × ZM 0060 Vibration Units and 1 × UA 0626 Blank Panel instead of the Direct, FM and Two Channel Compander Units. Also, 4 BNC and TNC Plugs JP 0035 and JP 0152, plus 4 TNC to 10-32 UNF Coax. Adaptors JP 0162 are included instead of the 8 BNC Plugs provided with Type 7005.

ACCESSORIES AVAILABLE

Leather Case	KE 0192
19 inch Rack Mounting Adaptor	KS 0040
AC Mains Adaptor/Charger	ZG 0199
690 m of Inst. Tape for Direct and FM Recording	QR 1003
Tape Loop Cassette	UD 0035
1,2 V Ni-Cd Cells	6 × QB 0008
Direct (Rec/Repro) Unit	ZE 0299
FM (Rec/Repro) Unit	ZM 0053
Vibration (FM Rec/Repro) Unit*	ZM 0060
Two Channel Compander Unit	ZM 0054
TNC to Miniature Coax. Plug Adaptor	JP 0162

* When Compander Unit is included a maximum of two Vibration Units together with two Direct Units or one FM Unit can be used

Specifications– Record-Reproduce Units

PLUG–IN UNIT		DIRECT UNIT ZE 0299		FM UNIT ZM 0053		VIBRATION UNIT ZM 0060	
EQUALIZATION		IRIG Intermediate Band Direct for tape speeds of		IRIG Wide Band FM – Group 1 for tape speeds of		IRIG Wide Band FM – Group 1 for tape speeds of	
		38,1 mm/s$^{\Delta}$ (1,5 in/s)	381 mm/s (15 in/s)	38,1 mm/s$^{\Delta}$ (1,5 in/s)	381 mm/s (15 in/s)	38,1 mm/s$^{\Delta}$ (1,5 in/s)	381 mm/s (15 in/s)
OVERALL FREQUENCY RANGE	Basic	20 Hz to 6 kHz ± 3 dB	40 Hz to 60 kHz ± 3 dB	DC to 1,25 kHz ± 1 dB (1,4 kHz –3 dB typ)	DC to 12,5 kHz ± 1 dB (14 kHz –3 dB typ.)	0,5 Hz to 1,6 kHz ± 1 dB	0,5 Hz to 7 kHz ± 1 dB (16 kHz –3 dB typ.)*
	With ZM 0054 Compander	20 Hz to 6 kHz ± 6 dB	40 Hz to 60 kHz ± 6 dB	10 Hz to 1,25 kHz ± 2 dB	10 Hz to 12,5 kHz ± 2 dB	10 Hz to 1,6 kHz ± 2 dB	10 Hz to 14 kHz ± 2 dB (20 kHz – 6 dB typ.)
SIGNAL TO NOISE RATIO	Basic	42 dB (Lin)	42 dB (Lin)	40 dB (Lin)	44 dB (Lin)	40 dB (Lin)**	40 dB (Lin)**
	With ZM 0054 Compander	> 70 dB (Lin) effective					
BIAS (CARRIER) FREQUENCY		250 kHz approx.		(5,4 kHz)	(54 kHz)	(5,4 kHz)	(54 kHz)
DC DRIFT (and LINEARITY)		Not applicable		< 1% of full deviation (from best straight line through zero centre)			
DISTORTION		< 1% (k_3) for 1,41 V Peak Output		< 1,5% (k_2) for 1,41 V Peak Output			
CROSS–TALK ATTENUATION		Better than signal–to–noise ratio (measured between any two adjacent Direct, FM or Vibration channels at frequency of 1 kHz)					
INPUT LEVEL$^{\Delta\Delta}$		31,6 mV to 31,6 V (45 V Peak) corresponding to 90 to 150 dB re 20 μPa with microphone sensitivity 50 mV/Pa				0,1 to 1000 pC (1400 pC Peak) corresponding to 0,1 to 1000 ms^{-2} (or mms^{-1} at 158 Hz) with accelerometer sensitivity 1 pC/ms^{-2}	
INPUT ATTENUATOR or RANGE ADJUSTMENT		0 to –60 dB in 10 dB steps, plus 0 to –13 dB cont. adj.				1 to 10 000 mV/pC (for mV/unit) in 10 dB steps	
INPUT IMPEDANCE		100 kΩ//100 pF					
OUTPUT		Output Level: 1 V RMS (1,41 V Peak) Output Impedance: ~5 Ω Max. Load: > 1 kΩ//2 nF					
OVERLOAD WARNING		Indicator lights for peak overloads + 3 dB above nominal record level. Separate indication for each channel					

Δ Non IRIG speed
$\Delta\Delta$ With respect to 0 dB nominal record level. Add 3 dB for max. level
* 20 kHz – 4 dB typical with Uni–Gain Accelerometers types 4371 and 4384
** From 0,3 Hz with Acceleration Mode and 20 Hz with Velocity Mode

T00190GB1

Specifications – Compander Unit ZM 0054

CHANNELS:
Two independent channels for automatic compression and expansion of input and output signal levels in accordance with their average level. Are used with the FM, Direct or Vibration Units employed with channels 3 and 4, and permit two completely separate non stationary signals with dynamic range of over 70 dB to be recorded and reproduced

FREQUENCY RANGE:
Choice of "Lin" (10 Hz to 60 kHz) and "A-Weight" (Type 1 IEC 651) modes modified by response of particular FM, Direct or Vibration Unit used. See Record–Reproduce Unit Specifications

SIGNAL INPUTS:
Separate "Direct" and "Preamp" voltage inputs for each channel. Bypass input and attenuator stage of Record–Reproduce Units used with channels 3 and 4. The "Preamp" inputs accommodate B&K ½ inch Microphone Preamplifiers Type 2642 and may be switched to supply 0, 28 or 200 V microphone polarization

Input Level*: 0,1; 1 and 10 V settings. Equiv. to 100, 120 and 140 dB re. 20 μPa with Microphone sensitivity 50 mV/Pa
Input Impedance: 100 kΩ//100 pF

Input Level*: 0,1; 1 and 10 V settings. Equiv. to 100, 120 and 120 dB re. 20 μPa with Microphone sensitivity 50 mV/Pa
Input Impedance: 100 kΩ//100 pF

SIGNAL OUTPUTS:
Output Level*: 1 V RMS (1,41 VPeak)
Output Impedance: 5 Ω
Max. Load: >1kΩ//2nF

OVERLOAD WARNING:
Indicator lights warn of peak overload +10 dB (at inputs) and +3 dB (at outputs) above 0 dB nominal record level

* With respect to 0 dB nominal record level

2. CONTROLS

The 4 channel Tape Recorder Type 7007 comprises of a tape transport and monitor mainframe fitted with four plug-in Vibration Units ZM 0060 and a rechargeable Battery Pack. To permit recording of sound and voltage signals with the 7007 an optional Two Channel Compander Unit ZM 0054 may be fitted. Also, one or more of the Vibration Units may be replaced by a Direct Unit ZE 0299 or FM Unit ZM 0053, details of which are given in Chapter 1 of this Manual and the Instruction Manual for Tape Recorders Types 7005 and 7006.

2.1. MAINFRAME OF TYPE 7007

2.1.1. Front and Top Panels

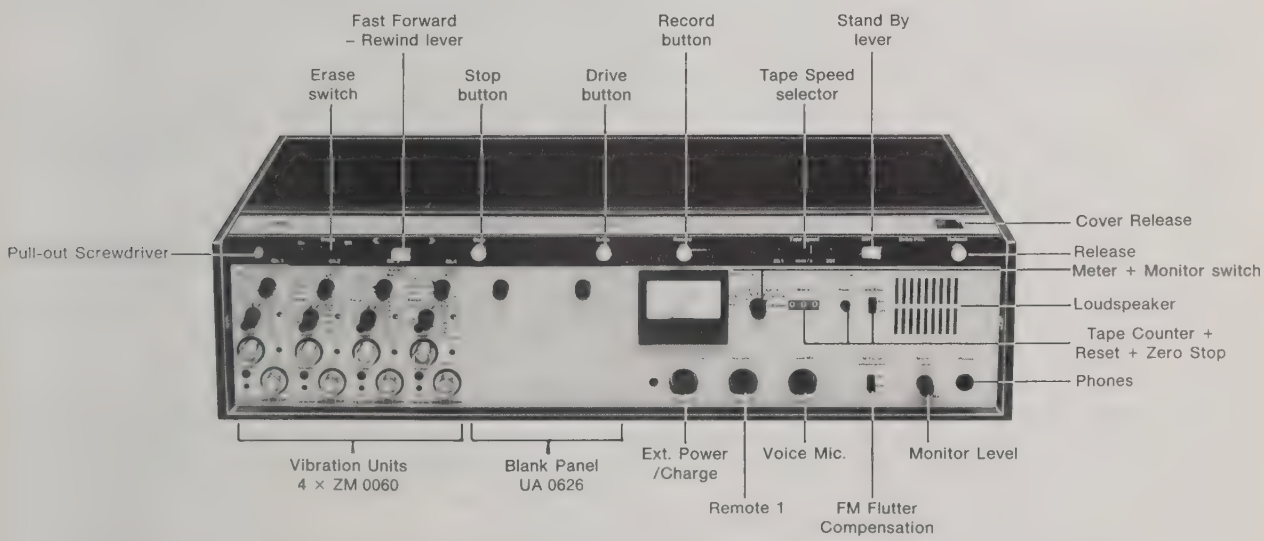


Fig. 2.1. Top and front panels of Tape Recorder Type 7007

COVER RELEASE: Locks the hinged lid of the Recorder. For tape loading the lid may be released by pushing the catch to the right. For protection of the tape transport and recording tape, the lid should be kept closed whenever tape is not being loaded.

WARNING: Always ensure that the knurled SPOOL LOCKS at the top of the drive hub spindles are tightened before closing the lid of the Recorder.

STAND BY:

2-position lever for selection of the following functions:

"Drive Pos.". Connects power and sets the capstan pressure wheels to their standby position ready for recording or playback of data when the RECORD and/or DRIVE push-buttons are pressed. The appropriate TAPE SPEED LED will be lit, informing that the tape drive and monitor circuitry are powered.

"Off". Selects the main power off mode of the Recorder, returning the capstan pressure wheels to their neutral position ready for tape loading. To reset the lever to "Off", press the RELEASE push-button.

RELEASE:

Push-button which when pressed stops the tape drive and/or resets the STAND BY lever to "Off", disconnecting power from the Recorder.

TAPE SPEED:

2-position switch for selection of "38,1 mm/s" (1,5 in/s) and "381 mm/s" (15 in/s) tape speed settings. With the STAND BY lever set to "Drive Pos.", the appropriate TAPE SPEED LED on the right or left of the switch will be lit. When the DRIVE push-button is pressed the LED will be momentarily extinguished and then relit when the Recorder has stabilized and locked onto the correct tape speed.

DRIVE:

Push-button for selection of tape drive for recording and reproduction of data. Electronic and mechanical interlocking ensures that DRIVE may only be selected when the STAND BY lever is set to "Drive Pos."

Note: The drive is automatically disconnected and the capstan pressure rollers lifted from the capstans when the voltage status of the internal or external supply is no longer sufficient for reliable operation.

RECORD:

Push-button for selection of the record mode. Electronic and mechanical interlocking ensures that the record mode may only be selected when the STAND BY lever is set to "Drive Pos." and the DRIVE button is momentarily pressed whilst keeping the RECORD button pressed.

STOP:

Push-button for stopping tape drive, as well as resetting the FAST FORWARD WIND - REWIND lever to "0" or the RECORD - DRIVE functions to stand by. It has no affect on the setting of the STAND BY lever and therefore may be used to provide a temporary stop during recording or playback of data.

FAST FORWARD WIND–REWIND:

Three position lever for selection of fast forward wind ">>" or rewind "<<" of the recording tape when the STAND BY lever is set to its "Off" position. At the end of the tape the FAST FORWARD WIND - REWIND lever will be automatically returned to its "0" position to stop the tape drive and disconnect power from the Recorder. For manual stop, press the STOP push-button.

ERASE:

"On"-"Off" switch for selection of full track erase with all four record channels of the Recorder. When full track erasure is taking place, an indicating LED beside the switch will be lit. Electronic interlocking ensures that erasure is operative only when RECORD plus DRIVE are selected for recording.

Note: The Vibration Units ZM 0060 as well as FM Units ZM 0053 (option) employ a frequency modulation record technique and therefore when selected for recording will automatically erase previously recorded data regardless of whether the ERASE switch is set to "On" or "Off".

SCREWDRIVER: A small pull-out screwdriver for adjustment of the calibration controls on the front of the record/reproduce units of the Recorder.

TAPE COUNTER: 3-digit mechanical counter giving a direct indication in metres of the amount of recording tape used. To the right of the counter is a RESET button for resetting the counter to "000" count.

ZERO-STOP: "On"-"Off" switch which when set to "On" and FAST REWIND (or FORWARD WIND) of the tape is selected, automatically stops the tape drive when "000" count is indicated by the TAPE COUNTER. Is used to facilitate fast location of the start of recorded data.

METER: A sensitive moving coil meter graduated from $-\infty$ to +3 dB, with 0 dB corresponding to the nominal record level. With the STAND BY "Drive Pos." or RECORD plus DRIVE selected, the meter indicates the max. peak (positive or negative, whichever is the greatest) input signal level of the particular channel selected with the MONITOR SWITCH. With just DRIVE selected for playback of recorded data, it monitors the max. peak output signal level of the selected channel. The meter is also used in checking the voltage status of the internal or external supply and in checking the calibration of the Recorder (see sections 3.4.1 and 4.1 respectively).

MONITOR SWITCH: 7-position switch enabling channels "Ch-1", "Ch-2", "Ch-3" and "Ch-4" to be selected in turn for monitoring via the built-in meter, loudspeaker etc. Positions "(Ch-3)" and "(Ch-4)" are for monitoring of Ch-3 and Ch-4 when the Two Channel Compander Unit ZM 0054 is used with the Vibration Units ZM 0060 included with these channels. The "Supply" position provides a meter check of the internal or external supply voltage.

PHONES: Output accepting a standard 6,35 mm jack plug (not supplied), for audio monitoring via a pair of external phones. The nominal output level and output impedance is 2 V RMS and 15 Ω respectively. The built-in loudspeaker is automatically disconnected when a jack plug is inserted.

MONITOR LEVEL: Volume control for audio monitoring via the built-in loudspeaker or external phones.

FM FLUTTER COMPENSATION: "On"-"Off" switch for recording and reproduction of an on-tape reference signal for post record flutter compensation with the FM recorded data. See section 4.7.

VOICE MIC: 3-pin socket for connection of the Voice Microphone MM 0021 supplied. By setting the slider switch on the microphone to "On", Ch-1 is selected for use as a voice channel, enabling comments on tape and measurement identities to be recorded with the aid of the microphone when RECORD plus DRIVE are selected for recording. See section 4.8.

REMOTE 1:

6-pin socket accepting a standard DIN plug or the B & K plug JP 0601 provided, for connection of remote RECORD—DRIVE, START—STOP control and indicating lines. For connections, see Fig. 2.2 and section 4.9.

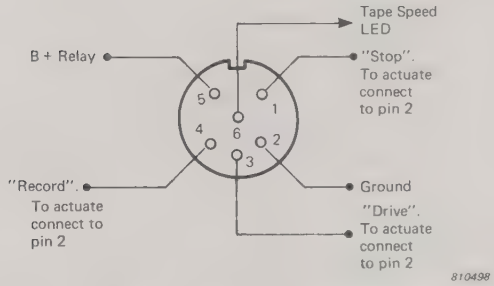


Fig. 2.2. External view of REMOTE 1 socket

EXT. POWER/CHARGE:

7-pin socket accepting a standard DIN plug or the B & K Cable AQ 0035 provided. Facilitates connection of an external DC source such as the Power Supply ZG 0199 (or earlier Type 2808) to power the Recorder and/or recharge its internal Battery Pack. See sections 3.4.2 and 3.4.3.

2.1.2. Rear Panel

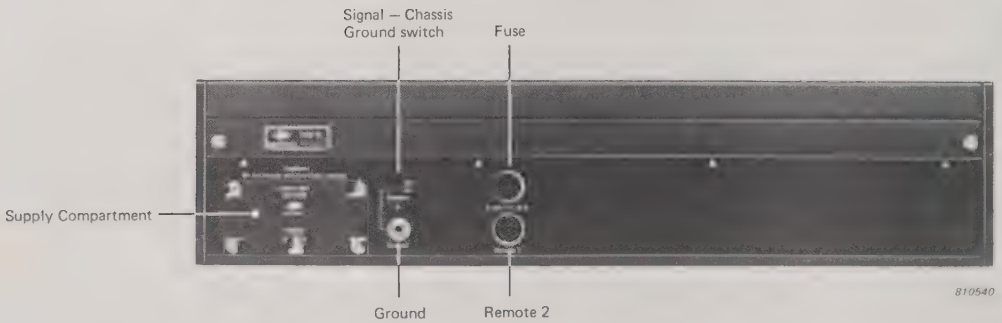


Fig. 2.3. Rear panel of the Tape Recorder Type 7007

SUPPLY COMPARTMENT:

Accepts a plug-in Battery Pack consisting of the Battery Box ZG 0146 plus six rechargeable Ni-Cd Batteries QB 0008 provided. For operation from an AC mains source, the Battery Pack can be replaced by a plug-in Power Supply ZG 0199 (or earlier Type 2808) which is available. For full details on the use of these supplies, section 3.4 should be consulted.

SIGNAL GROUND:

"On"-"Off" switch for connection or disconnection of the input or output signal ground lines of the Recorder from chassis. See "Grounding Considerations", section 3.5.

WARNING! The 7007 is designed to be operated with its signal ground lines and chassis always at earth potential. Never let the signal ground lines, socket screens or chassis float at other than approxi-

mately zero earth potential as this will impair the operating safety of the Recorder and may damage it.

GROUND: 4 mm socket accepting a standard banana plug (B & K no. JB 0002) for connection of the chassis of the Recorder to a suitable earth.

FUSE: Fuse holder containing a 2,5 A slow blow cartridge fuse (B & K no. VF 0029) for protection of the Recorder when powered using an external DC source. Before attempting to check or replace the fuse, remove the internal Battery Pack and disconnect any external power supply which may be connected.

REMOTE 2: 8-pin socket accepting the standard DIN plug (B & K no. JP 0802) provided. It has the pin designations shown in Fig. 2.4 and provides a marker pulse which for automatic frequency analysis of tape loop recorded data, permits synchronous operation of the B & K Band Pass Filters Type 1617 and 1618 with the Recorder. See section 3.7.

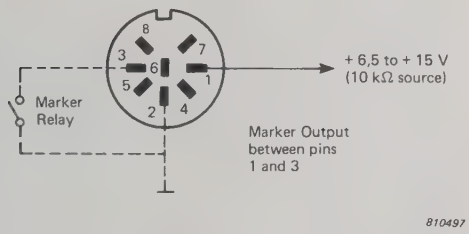


Fig. 2.4. External view of the REMOTE 2 socket

2.2. VIBRATION UNIT ZM 0060

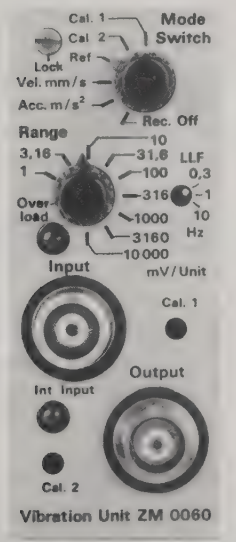


Fig. 2.5. Front panel of Vibration Unit ZM 0060

LOCK: Screwdriver operated lock for securing the Vibration Unit ZM 0060 in the mainframe of the Recorder. To install or replace the Unit, see section 3.3.

MODE SWITCH: 6-position switch for selection of the following functions:

"Rec. Off". Selects reproduce section for reproduction of recorded data with the record section disabled and disconnected from the INPUT socket.

"Acc. m/s^2". Selects linear mode for recording of vibration acceleration of amplifier operation with sensitivities from 1 mV/unit to 10 000 mV/unit.

"Vel. mm/s". Selects single integration mode for recording of velocity measurements with sensitivities from 1 mV/unit to 10 000 mV/unit.

"Ref". Applies internal 1 kHz sinusoidal reference signal, which may be used as an on-tape reference for calibration of external equipment employed for measurement and analysis of reproduced data.

"Cal. 1" – "Cal. 2". Apply internal reference signal, against which the reproduce section FM demodulator and record section FM modulator may be balanced to give minimum pointer deflection on the meter. Adjustment is carried out with the Cal. 1 and Cal. 2 potentiometers when the STAND BY "Drive Pos." is selected on the Tape Recorder. See section 4.1.

RANGE 9-position input range selector. It is graduated in terms of reproduce section output rating (e.g. 10000 to 1 mv/vibration unit) and for operation with B&K Uni–Gain® Accelerometers Types 4371 and 4384, permits corresponding input levels between 0,1 and 1000 units to be accommodated at the 0 dB nominal record level. See Table 4.1.

LLF: 3-position screwdriver operated switch for selection of 0,3, 1 and 10 Hz –3 dB lower limiting frequencies with the record section. Helps elimate low frequency noise produced by piezoelectric transducers not having a low temperature transient sensitivity.

OVERLOAD: A LED indicator which when lit warns that the input level exceeds the +3 dB max. peak record level or input rating of the charge amplifier.

INPUT: A charge coupled coaxial input socket for connection of B & K Uni–Gain® Accelerometers and other types of vibration measurement transducer to the record section of the Vibration Unit. Accepts the TNC connector (B&K no. JP 0152) and TNC to 10–32 UNF Adaptor (B&K no. JP 0162) provided.

INT. INPUT: A LED indicator which when lit informs that the charge amplifier has been internally disconnected and that the Vibration Unit is coupled with the Two Channel Compander, FM Flutter Compensation facility or Voice Microphone of the Recorder. See also sections 4.5, 4.7 and 4.8 respectively.

OUTPUT: DC coupled voltage output from the reproduce section. It accepts the BNC plug provided and has an output impedance of approximately

5 Ω. However, for maximum output voltage of 2 V peak with 1 V RMS (1,41 V Peak) corresponding with the 0 dB nominal record level, it should not be loaded by less than 1 kΩ, or greater than 2 nF.

CAL.1 - CAL.2: Two screwdriver operated potentiometers for adjusting the balance of the reproduce section FM demodulator and record section FM modulator respectively. See also section 4.1.

2.3. TWO CHANNEL COMPANDER UNIT ZM 0054

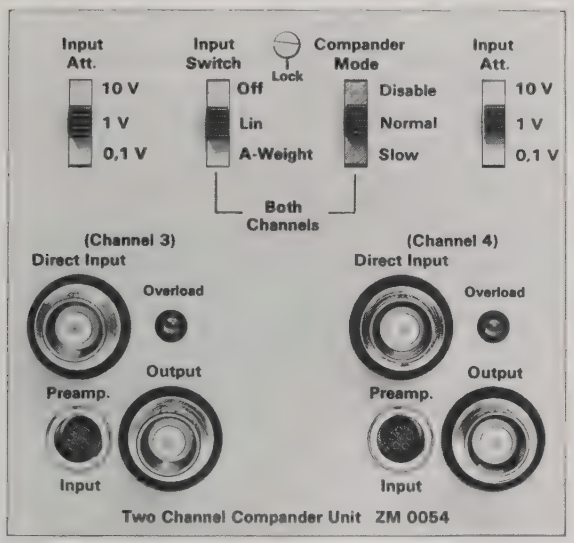


Fig. 2.6. Front panel of the Two Channel Compander Unit ZM 0054

LOCK: Screwdriver operated lock for securing the Two Channel Compander ZM 0054 in the mainframe of the Recorder. To install the Compander or replace with a Blank Panel UA 0626, see section 3.3.

INPUT SWITCH: 3-position switch for selection of the following settings:

"Off". Compander "Power Off" mode. However, to facilitate recording of sound measurements without automatic gain regulation by the Compander, the microphone PREAMP. INPUT sockets of the Unit are kept powered as long as the STAND BY lever remains set to "Drive Pos.". See section 4.5.1 and 4.5.2.

"Lin.". Compander "Power On" mode with channels (Ch-3) and (Ch-4) of the Compander coupled to the Vibration Units of channels Ch-3 and Ch-4 respectively. The charge amplifier and integrator circuits plus RANGE and LLF switches of the Vibration Units are disconnected internally and the record section coupled with the DIRECT and PREAMP. INPUT sockets plus the INPUT ATT. switch of the Compander. In addition a linear input response is selected with both channels.

"A-Weight". Same as "Lin." setting, but with "A" weighting selected for input response in accordance with Type 1 frequency weighting characteristics of IEC 651 for precision sound level meters.

COMPANDER MODE: 3-position switch for selection of the following functions:

"Disabled". Bypasses the automatic gain regulation circuits of the Compander. Enables the Vibration Units of channels 3 and 4 to be employed for recording of voltage and acoustic signals via the DIRECT and PREAMP. INPUT sockets of the Compander. See section 4.5.2.

"Normal" – "Slow". Actuate automatic gain regulation circuits of the Compander, facilitating unattended recording and reproduction of non stationary signals with dynamic range of over 70 dB. "Normal" and "Slow" refer to the speed of automatic gain regulation which is 200 dB/s and 20 dB/s respectively. See section 4.5.3.

The following front panel controls and sockets are duplicated for both channels (Ch-3) and (Ch-4) of the Compander.

INPUT ATT. Two 3-position switched attenuators for independent attenuation of the input signal applied to channels (Ch-3) and (Ch-4). The "0,1 V", "1 V" and "10 V"' settings of the switches, denote the input voltage level required to produce 0 dB record level indication on the meter.

DIRECT INPUT: Two AC coupled - voltage inputs, one for each of channel of the Compander. They accept the BNC plugs (B & K no.JP 0035) provided and enable two separate signals to be recorded via channels (Ch-3) and (Ch-4) of the Compander. The inputs have an input impedance of 100 kΩ // 100 pf and for operation in accordance with IEC 348 safety requirements, have a maximum input voltage rating of 50 V RMS - 70 V Peak.

PREAMP. INPUT: Two 5-pin sockets, one for each input channel of the Compander. They enable two B & K Microphone Preamplifiers Type 2642 to be connected for recording of sound measurements via channels (Ch-3) and (Ch-4) of the Compander. Besides serving as a signal input, they also provide the supply voltages necessary for operation of the Microphone Preamplifiers and associated microphones. These voltages remain available as long as the STAND BY lever is kept set to "Drive Pos.". For socket connections, see Fig. 2.7.

WARNING! Before connecting the PREAMP. INPUTs with a Microphone Preamplifier, ensure that the Preamplifier is correctly fitted with a Microphone and check that the POL. VOLT. switch on the rear of the Compander Unit is set to provide the correct microphone polarization voltage. If not the Microphone and Preamplifier combination may be damaged.

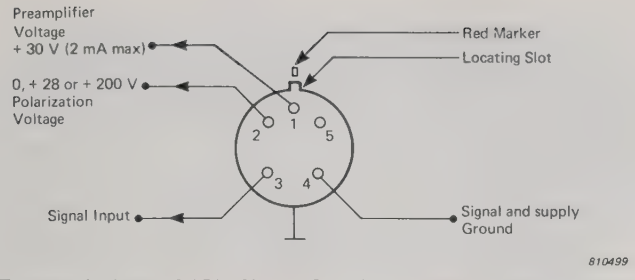


Fig. 2.7. External view of (Ch-3) or (Ch-4) PREAMP. INPUT socket

OUTPUT:

Two AC coupled - voltage outputs, one for each output channel of the Compander. They accept the BNC plugs (B & K no. JP 0035) provided and have an output impedance of approximately 5 Ω. However, for maximum output voltage of 2 V peak with 1 V RMS - 1,41 V Peak corresponding to the nominal record level, they should not be loaded by less than 1 kΩ or greater than 2 nF.

OVERLOAD:

Two LED indicators, one for each channel, which when lit warn of input and/or output section overload of the Compander by input signal levels +10 dB above the 0 dB nominal record level or by output signal levels +3 dB above the 0 dB nominal reproduce level.

POL. VOLT:

3-position switch, located on the rear of the Compander. Is used for selection of microphone polarization voltage available at the (Ch-3) and (Ch-4) PREAMP. INPUT sockets of the Compander. The "0 V" setting is for prepolarized microphones, whilst the "28 V" and "200 V" settings are for condenser microphones.

WARNING! To prevent damage, always select the required POL. VOLT. setting before connecting a Microphone and Preamplifier combination and wait until both the Microphone and Preamplifier have been connected before setting the STAND BY lever to "Drive Pos." for powering the Recorder.

3. PRELIMINARY

3.1. ENVIRONMENT AND HANDLING

The B & K Tape Recorder Type 7007 is a robust instrument which is especially designed for combined field and laboratory use. It is suited for mobile as well as bench use in either a horizontal or vertical position. Operation in environments with temperatures from -10° to +50°C (+14° to +122°F) and humidities up to 90% RH (noncondensing) at 30° C is possible, provided that the recording tape is also suited for operation within these limits. For example, with the instrumention grade Recording Tape QR 1003 (Ampex 797 or equivalent) supplied, use at temperatures from +5° to +50°C (+40° to +122°F) and humidities from 25 to 90% RH can be tolerated.

In addition to the above, the following should be observed to ensure reliable operation in accordance within published specifications:

- Use Ampex 797 (B & K no. QR 1003) or an equivalent recording tape, only.
- Avoid excessive over-recording on previously used tape, as this can lead to a deterioration in record-reproduce frequency response and noise.
- To prevent contamination by dust and other foreign matter, keep the lid of tape transport closed and return the recording tape to its original packing immediately after use.
- To help safeguard the Recorder during transport or field use, fit the Leather Case KE 0192.
- Regularly clean the Recorder, especially when it has been used in contaminated environments.
- Remove the plug-in Battery Pack and store separately, whenever the Recorder is not to be used for longer than one week. Also remove the Battery Pack for air-freight or operation at high altitudes.

3.2. TRANSPORTATION AND RACK MOUNTING

For carrying the 7007, a foam grip Handle DH 0402 plus adjustable Shoulder Strap DH 0427 is provided. This has integral screw fastenings, enabling either to be attached to the Recorder via the threaded holes at the front of the side panels. When employed for bench use with the carrying handle fitted, the front of the Recorder may be raised by pulling forward and lowering the carrying handle as a stand.

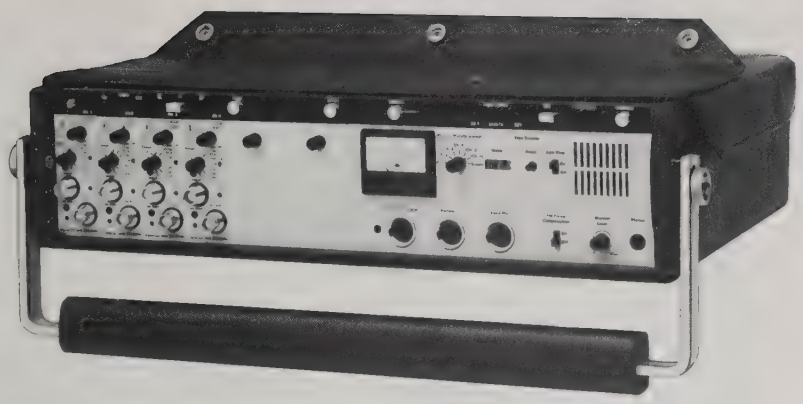


Fig. 3.1. Tape Recorder Type 7007 with Leather Case KE 0192 and foam grip Carrying Handle DH 0402 fitted

To help safeguard the Recorder when transported or employed for field use, it is recommended that it be used with the Leather Case KE 0192 which is available. This may be fitted as shown in Fig. 3.1 and has a flapped snap fastened lid which may be either pulled back or taken off so as to permit ready access to the front panel controls as well as the tape compartment of the Recorder. The case is held in place by the screw fastening used to attach the carrying handle or shoulder strap which must first be removed in order to fit the case.

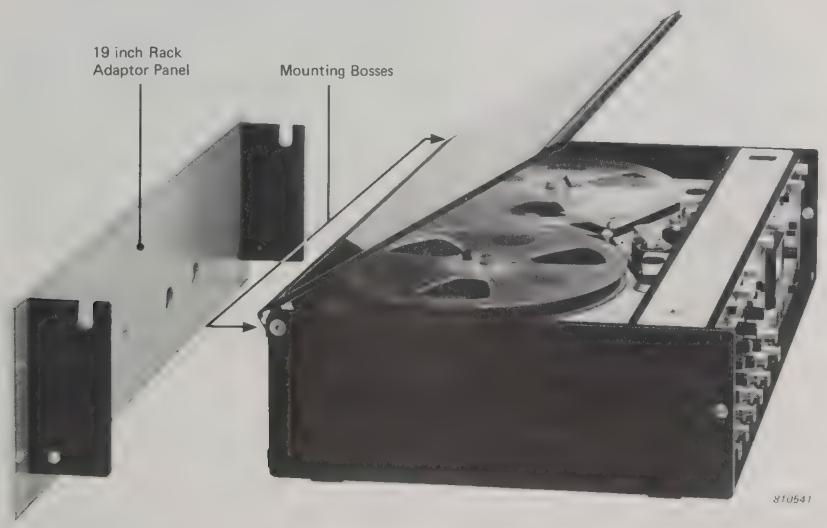


Fig. 3.2. Use of the 19 inch Rack Mounting Adaptor KS 0040

Also available for the Recorder is a Rack Mounting Kit KS 0040. This is shown in Fig. 3.2 and includes an adaptor panel for bolting directly on the front of a 19 inch instrumentation rack, plus a pair of black plastic bosses for securing the Recorder between the slots of the supporting flanges on the front of the adaptor panel. The bosses screw one on either side of the Recorder via the screw holes at the rear of its side panels. Each hole has a black plastic insert which may be removed by poking them out from inside the tape compartment. If required, the metal cabinet of the Recorder may be electrically isolated from the rack by covering the inside faces of the

supporting flanges with a thin layer of felt or other insulating material. See "Grounding Considerations", section 3.5.

3.3. INSTALLATION OF PLUG–IN UNITS

In Fig. 3.3 are indicated the compartment locations for the various plug-in units used with the record-reproduce channels of the 7007. These are classified in accordance with the particular channel or channels with which they are used. The locations "Ch-1" through to "Ch-4" may each be fitted with a Vibration Unit ZM 0060 or an optional FM or Direct Unit ZM 0053 and ZE 0299, while the location "(Ch-3)-(Ch-4)" is reserved for fitting a Two Channel Compander Unit ZM 0054 and permits recording of sound and voltage signals in conjunction with the units installed in Ch-3 and Ch-4. All units are delivered ready for immediate installation and require no internal adjustment.

Note: When used with the Two Channel Compander a maximum of four FM and Direct Units or two Vibration Units together with two Direct Units or one FM Unit may be employed.

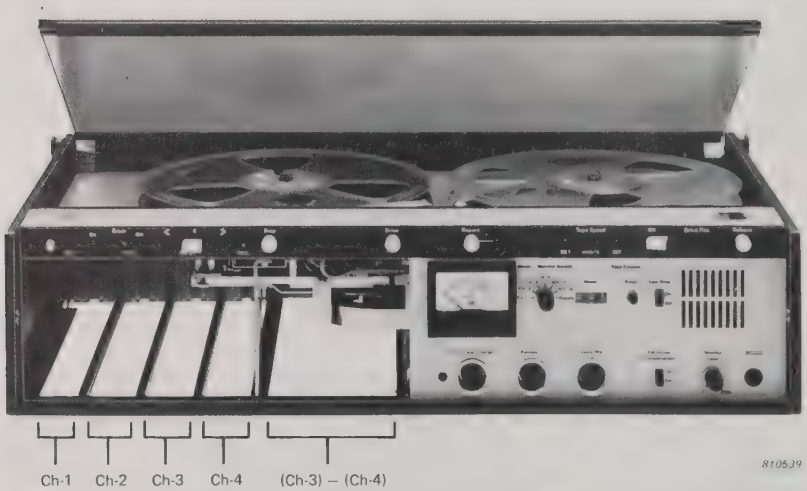


Fig. 3.3. Compartment locations and channel identities with the 7007

To fit or replace a plug-in unit, proceed as follows:

1. Check that the STAND BY lever of the Recorder is set to "Off". If not, press the RELEASE push-button to disconnect power from the Recorder.

2. On the unit to be replaced, turn the screw head LOCK to its horizontal position, using the small pull-out screwdriver shown in Fig. 3.3.

3. Fit the OUTPUT socket of the unit with a BNC plug and use the plug to ease the front of the unit slightly upwards and then pull it out of the Recorder.

4. Locate the replacement unit over the end of the guide rails of the appropriate channel compartment and carefully slide it into the Recorder until it makes contact with the sockets at the rear of the compartment.

5. Carefully push the unit against the internal sockets and when completely inserted ease the bottom lip of its front panel into the retaining groove at the front of the compartment. Finally lock the unit in the Recorder using the small pull-out screwdriver to turn the screw head LOCK to its vertical (click-stop) position.

To prevent ingress of dirt and other foreign matter, avoid use of the 7007 without a full complement of plug-in units or blank panels fitted.

3.4. INSTALLATION OF BATTERY PACK AND CONNECTION OF EXTERNAL SUPPLIES

The 7007 is equipped with a plug-in Battery Pack, but may be also conveniently powered using an AC mains adaptor or an external DC supply. Operation with these types of supply is discussed in the following sections.

3.4.1. Plug-in Battery Pack

The plug-in Battery Pack provided with the Recorder consists of the Battery Box ZG 0146 containing six rechargeable Ni-Cd Cells QB 0008. The cells have a voltage and charge rating of 1,2 V and 4 A.hours respectively, and with normal use may be recharged a minimum of 500 times before needing to be replaced. With each charge the cells may be used to provide between 3 to 5 hours of continuous operation with the Recorder, depending on the particular tape speed setting and operating mode selected. If operation for a longer period is required, then a spare set of Ni-Cd cells or a spare Battery Pack should be kept as a reserve.

Installation of Plug-in Battery Pack

The plug-in Battery Pack is delivered in a charged condition and therefore is ready for immediate use. To plug it into the supply compartment of the 7007 proceed as follows:

1. Remove the Leather Case to make the rear panel of the Recorder accessible.

2. Place the Battery Pack in the position shown in Fig. 3.4, so that the channel on the bottom of the Battery Pack is located over the end of the guide rail in the supply compartment of the Recorder.

3. Using the guide rail to guide the Battery Pack, push the Battery Pack into the supply compartment, so that when almost completely inserted, it just comes to rest against the pole contacts in the Recorder.

4. Using a firm but not excessive pressure, push the Battery Pack against the pole contacts and when completely inserted turn its screw head RELEASE catch so that it is located in the slot at the outer end of the guide rail.

Battery Check

Before each use of the Battery Pack it is recommended that its voltage status be checked to see that it is sufficient for powering the Recorder. To do this fit the Recorder with the Battery Pack and set its STAND BY lever to "Drive Pos.". With the MONITOR switch set to "Supply", the meter pointer of the Recorder should deflect to the center of the "Batt." check range of the meter scale. If not, and the pointer deflection is outside or only just inside the "Batt." range, the Battery Pack will need recharging as

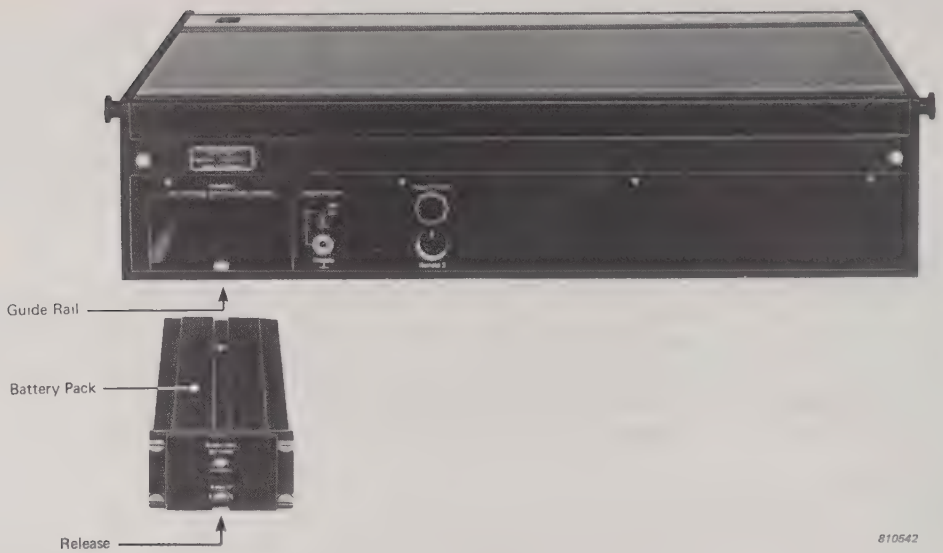


Fig. 3.4. Installation of plug-in Battery Pack

described in section 3.4.2 or 3.4.3. Alternatively it should be replaced by a spare Battery Pack or be fitted with a spare set of Ni-Cd cells which are already charged.

Note:

- For a reliable Battery Pack voltage check, disconnect all external supplies from the Recorder.
- The plug-in Battery Pack is automatically disconnected from the internal supply lines when its voltage status falls below that necessary for reliable operation of the Recorder.

Replacement of Ni-Cd Cells

To fit the Battery Pack with a spare set of charged Ni-Cd Cells QB 0008, proceed as follows:

1. Using a screwdriver, release the lid of the Battery Box by turning the screw headed fastenings indicated in Fig. 3.5.
2. Gradually tilt the Battery Box so as to slide out the cells to be replaced.
3. Load six freshly charged Ni-Cd Cells QB 0008 as shown in Fig. 3.5. Care should be taken to ensure that the positive pole (stud on cell casing) faces the direction indicated in each of the two compartments of the box.
4. Replace the lid of the Battery Box and lock it in place, using a screwdriver to turn the screw headed fastenings on the box.

WARNING! Never fit Ni-Cd cells with their poles reversed. Similarly, never mix different makes or types of cell, or cells which have been used to power other instruments. This can cause internal reversal of the cell polarity, increasing the chance of leakage from the cells, as well as making them unsafe when recharging is carried out.

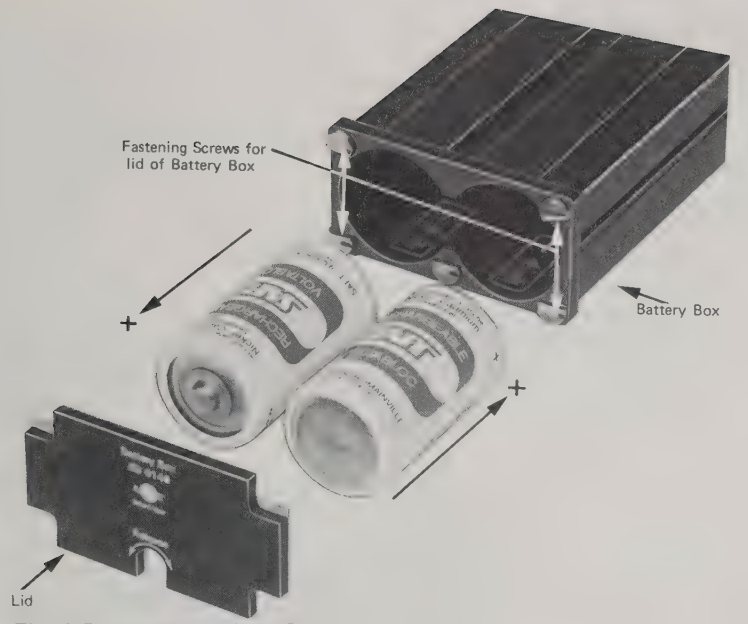


Fig. 3.5. Insertion of Ni-Cd Cells QB 0008 in the Battery Box ZG 0146

3.4.2. Plug-in AC Mains Adaptor and Charger

For operation of the Recorder from a 100 to 240 V (50 to 400 Hz) AC mains source, the Power Supply ZG 0199 (or earlier Type 2808) may be used. This is shown in Fig. 3.6 and may be employed externally for powering the Recorder, while at the same time recharging its plug-in Battery Pack. Alternatively, it may be employed as an internal supply in place of the Battery Pack if only mains operation of the Recorder is required.

Fig. 3.6. Plug-in Power Supply ZG 0199

Powering the Recorder

Before each use of ZG 0199 with the Recorder, carry out the mains voltage setting and fuse checks described in its Instruction Manual and press the RELEASE and STOP push-buttons of the Recorder to disconnect the Battery Pack. Once this has been done, plug ZG 0199 into the supply compartment of the Recorder in place of the Battery Pack (see section 3.4.1) or connect it to the EXT. POWER/CHARGE socket of the Recorder using the standard 7-way DIN Cable AQ 0035 provided. ZG 0199 may then be connected to a mains source and its FUNCTION SELECTOR switch set to "Drive On" - "Charge Off", ready for powering the Recorder.

Recharging the Battery Pack

For recharging the Ni-Cd Cells QB 0008 whilst fitted in the Battery Pack of the Recorder, connect ZG 0199 to the EXT. POWER/CHARGE socket of the Recorder as described above and set its FUNCTION SELECTOR switch to "Drive Off"–"Charge On" or "Drive On"–"Charge On". When the mains source is connected, the "Charge" LED on the front of ZG 0199 will light, indicating that the Ni-Cd cells are on charge. There is no need to set the STAND BY lever of the Recorder to its "Drive Pos.", unless it is also required to power the Recorder at the same time.

With totally discharged cells, the charge time is approximately 14 hours, at the end of which time the FUNCTION SELECTOR switch of ZG 0199 should be set to "Charge Off". There is no danger of overcharging by charging for a longer period, however, this is not generally recommended as it can reduce the life time of the cells. If the cells fail to reach a fully charged condition (see Battery Check procedure, section 3.4.1) after having been left on charge for 14 hours, then they should be replaced.

Where it is required to recharge Battery Packs outside the Recorder, ZG 0199 may be used together with the Charging Adaptor AQ 0157. This enables the Recorder to be used for field work with a spare Battery Pack fitted, while discharged Battery Packs are being recharged in the laboratory. For further information on the use of the AQ 0157, the Instruction Manual for ZG 0199 should be consulted.

3.4.3. Connection of External DC Source

Connection of the 7007 with an external battery or other external DC source is made via the EXT. POWER/CHARGE socket on the front panel of the Recorder. This has the pin identities shown in Fig. 3.7 and accepts a standard 7-pin DIN plug (B & K no. JP 0703) or one with integral screw lock (B & K no. JP 0710).

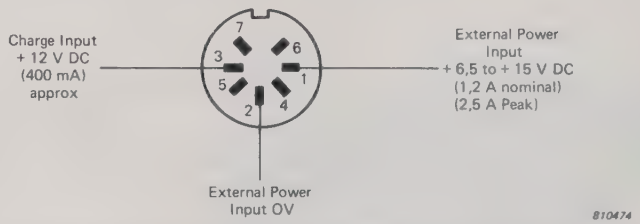


Fig. 3.7. External view of the EXT. POWER/CHARGE socket

Powering the Recorder

For powering the Recorder an external 6,5 to 15 V DC source may be used with its positive line connected to pin 1 of the EXT. POWER/CHARGE socket and its negative line connected to pin 2. The nominal and max. instantaneous current consumption of the Recorder is 1,2 and 2,5 A respectively. There is no need to remove the plug-in Battery Pack from the supply compartment, as this will be automatically disconnected from the internal power lines when external power is applied. However, its charge line is left connected so as to permit recharging to be carried out.

Recharging the Plug-in Battery Pack

For recharging the Ni-Cd Cells QB 0008 in the Battery Pack of the Recorder an external DC source providing approximately 12 V at 0,4 A is required . This should be con-

nected with its positive line to pin 3 of the EXT. POWER/CHARGE socket and its negative line to pin 2. Once the external charge source is connected, it will commence to charge the Ni-Cd cells regardless of whether the Recorder is set to the power "On" mode or not. However, when not using an external DC source to power the Recorder, it is recommended that the STAND BY and FAST FORWARD WIND levers are set to "Off", in order to restrict the maximum current drain with the external charge source to 0,4 A.

With totally discharged Ni-Cd cells the recharge time is approximately 14 hours. Although there is no danger of over charging by leaving the cells on charge for a longer period, this is not generally recommended as it can reduce the life time of the cells. If the cells fail to provide a correct "Batt" check indication (see section 3.4.1) after having been left on charge for 14 hours, then they should be replaced.

Powering and Charging from Car Battery

Where simultaneous operation and charging is required using a single external DC source, the Recorder may be connected with a 12 V car battery as shown in Fig. 3.8. However, before connecting the battery it is important that its voltage be checked. If it is found to deliver more than 15 V, then a suitable voltage dropping resistance should be included in the external power and charge lines to prevent damage to the Recorder.

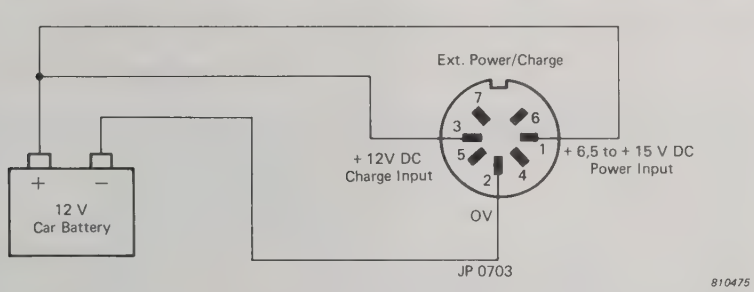


Fig. 3.8. Connection of 12 V car battery for powering and charging a 7007

WARNING! When a cars' own 12 V battery is employed, it should be checked that the metal cabinet of the Recorder and of other equipment with which it is used does not touch the metal bodywork of the car. This is particularly important with cars having a positive earth system, as when the battery is connected the chassis of the instruments will be at a potential 12 V lower than the car chassis and could short circuit the battery if they make contact with the car bodywork. If by chance this does occur, then the protection fuse contained in the fuse holder on the rear panel of the Recorder will be blown. See section 2.1.2.

3.5. GROUNDING CONSIDERATIONS

Indiscrimate grounding of measurement equipment can introduce ground loop interference. To prevent this it is necessary to ensure that the signal ground lines of the 7007, as well as of other equipment with which it is being used, are either isolated from ground or are grounded at one point only in the measurement system. To do this without prejudicing the operating safety of the measurement system, proceed as follows:

1. Connect the signal ground lines of all instruments together. This is done automatically through the screens of the input and output cables used to interconnect the instruments.

2. Check that the measurement transducers are not touching one another and are electrically isolated from electrically conductive or grounded measurement sources.

3. Check that the metal cabinets of the instruments in the recording arrangement are not touching one another. Use isolating flanges if the instruments are to be rack mounted.

4. Where one or more of the instruments is equipped with a mains input chassis connector, check that one and only one of them has both its signal ground line and chassis connected to mains ground.

5. With each of the remaining instruments having a mains connector, check that the chassis is connected to either a) mains ground only or b) signal ground only. Generally a) is to be preferred with instruments having a mains input chassis connector.

For correct grounding in accordance with the above requirements, the 7007 is equipped with a CHASSIS–SIGNAL GROUND "On/Off" switch on its rear panel. Normally this switch should be set to the "On" position (ie., chassis and signal ground interconnected), except where otherwise stated above.

3.6. TAPE LOADING

The 7007 Recorder accepts 6,35 mm (0,25 in) wide, ferrous oxide recording tape, in either spool or tape loop form. With the 18 cm (7 in) spool of Recording Tape QR 1003 and the B & K Tape Loop Cassette UD 0035 supplied, a wide-band instrumentation tape (Ampex 797 or equivalent) is used which is suitable for both FM and Direct recording. Where extra tape is required, additional quantities of QR 1003 or UD 0035 may be ordered from B & K. Alternatively, an equivalent wide-band, professional or instrumentation grade tape may be used.

3.6.1 Loading of Tape Spools

The 18 cm spool of Recording Tape QR 1003 contains approximately 690 metres (2300 ft). This may be loaded on the tape transport of the Recorder as explained below, and for operation with a tape speed setting of 38,1 mm/s (1,5 in/s) may be used to provide up to 5 hours of continuous recording.

1. Ensure that the STAND BY lever is set to "Off". If not, press the RELEASE push-button.

2. Push the COVER RELEASE catch to the right and hinge back the lid of the tape transport compartment. See Fig. 3.9.

3. Partially unscrew the SPOOL LOCKs on both drive hubs of the Recorder.

4. Fit the spool of recording tape to the left-hand drive hub and an empty spool of the same diameter to the right-hand drive hub.

5. Ensure that the slots at the centre of each spool are properly located over the three protruding pins at the centre of the drive hubs and screw the SPOOL LOCKS tight to lock the tape spools. For fitting suitable "stop" tape, see section 3.7.

6. From the spool of recording tape pull out approximately 1 m (3 ft) of tape and thread it between the two tape tension sensors "A" and "B" so that the magnetic coating of the tape faces "A". The magnetic coating side of the tape is usually that facing the center of the spool on which it is wound and can be either the polished or matt side of the tape.

7. Now take the end of the tape past the two tape guides "C" and "D" and back again between the tape tension sensors "A" and "B" so that the magnetic coating faces the record - reproduce heads and the tape tension sensor "B".

8. Place the free end of the tape between the flanges of the empty spool and attach it to the centre hub of the spool. Turn the empty spool clockwise to wind on approximately 15 turns of tape, or turn until the optically reflective "stop" passes the record/reproduce heads.

9. Before closing the lid of the Recorder, check that the tape is not twisted and that it is properly centred between the flanges of the tape tension sensors and the tape guides.

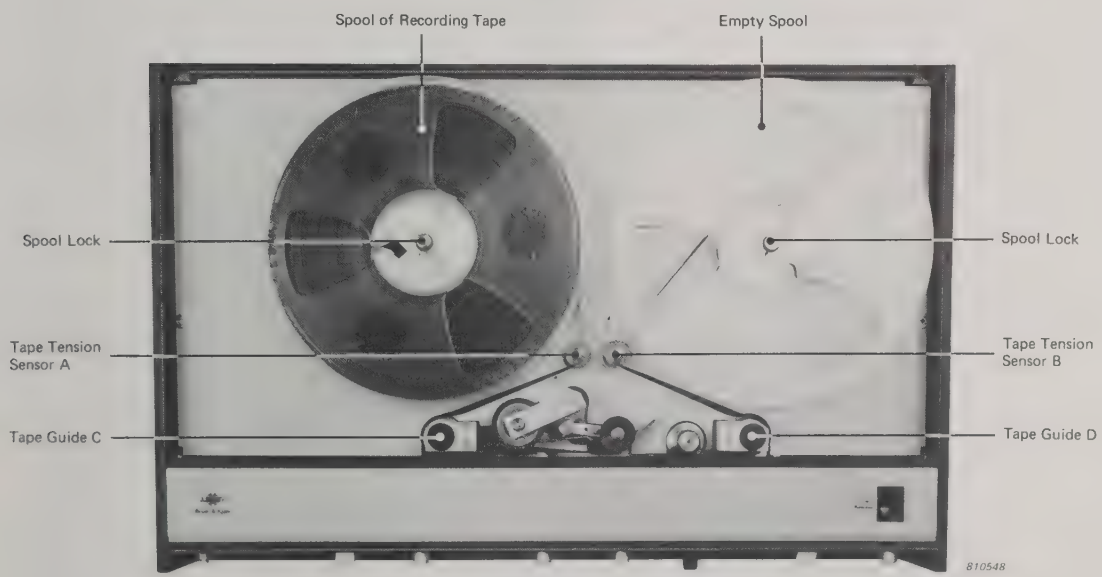


Fig. 3.9. Loading of tape spools

3.6.2. Loading B&K Tape Loop Cassettes

The Tape Loop Cassette UD 0035 fits over the drive hubs of the Recorder in place of tape spools and is used to facilitate recording and repetitive playback of short duration signals for frequency analysis. To save threading tape loops by hand it is supplied preloaded with a 2,52 metre (99 in) tape loop, which for reproduction and analysis with tape speed settings of 381 and 38,1 mm/s, gives signal repetition times of 6,6 and 66 s respectively. However, other tape loops may be fitted if different repetition times or analysis of short samples of spool recorded data is required.

Loading Tape Loop Cassettes

1. Ensure that the STAND BY lever is set to "Off". If not, press the RELEASE push-button.

2. Push the COVER RELEASE catch to the right and hinge back the lid of the tape transport compartment.

3. Partially unscrew the SPOOL LOCKS on both drive hubs of the Recorder. See Fig. 3.10.

4. Position the Cassette over the tape transport so that the fork ends of the Cassette are almost flush with the front inside edge of the tape transport compartment and that the rear of the locating slots "E" and "F" of the Cassette are centred over the drive hub SPOOL LOCKS.

5. Gently lower the Cassette onto the tape transport so that the straight portion of tape between the forked ends of the Cassette is between the record/reproduce heads and the tape guides "C" and "D".

6. Push the Cassette towards the rear of the Recorder so that the front of the locating slots "E" and "F" of the Cassette are in contact with the drive hub SPOOL LOCKS. When this is done the tape tension sensors "A" and "B" are pushed apart by the plastic cover of the Cassette, disengaging the drive hubs from the main drive of the Recorder.

7. Check that the portion of tape between the forked ends of the Cassette is centred correctly on the tape guides "C" and "D", and then tighten the SPOOL LOCKS to lock the Cassette onto the Recorder.

8. Finally, close the lid of the Recorder.

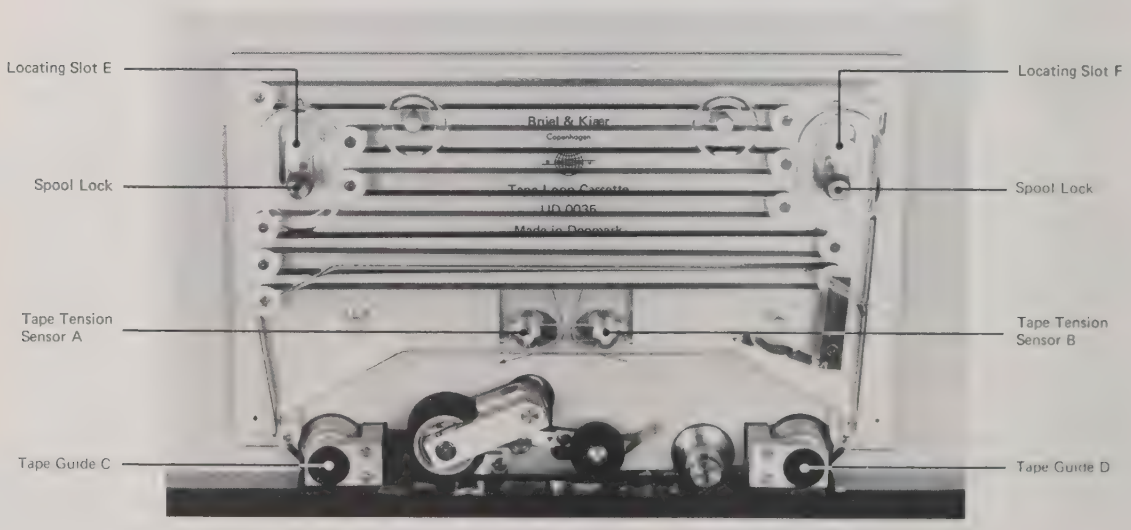


Fig. 3.10. Loading of Tape Loop Cassettes UD 0035

Fitting Tape Loops to the Tape Loop Cassettes

To fit a B & K Tape Loop Cassette with a new tape loop or one of different length, proceed as follows:

1. Unscrew the four knurled nuts "A", "B", "C" and "D" on the Cassette and remove its plastic cover. See Fig. 3.11.

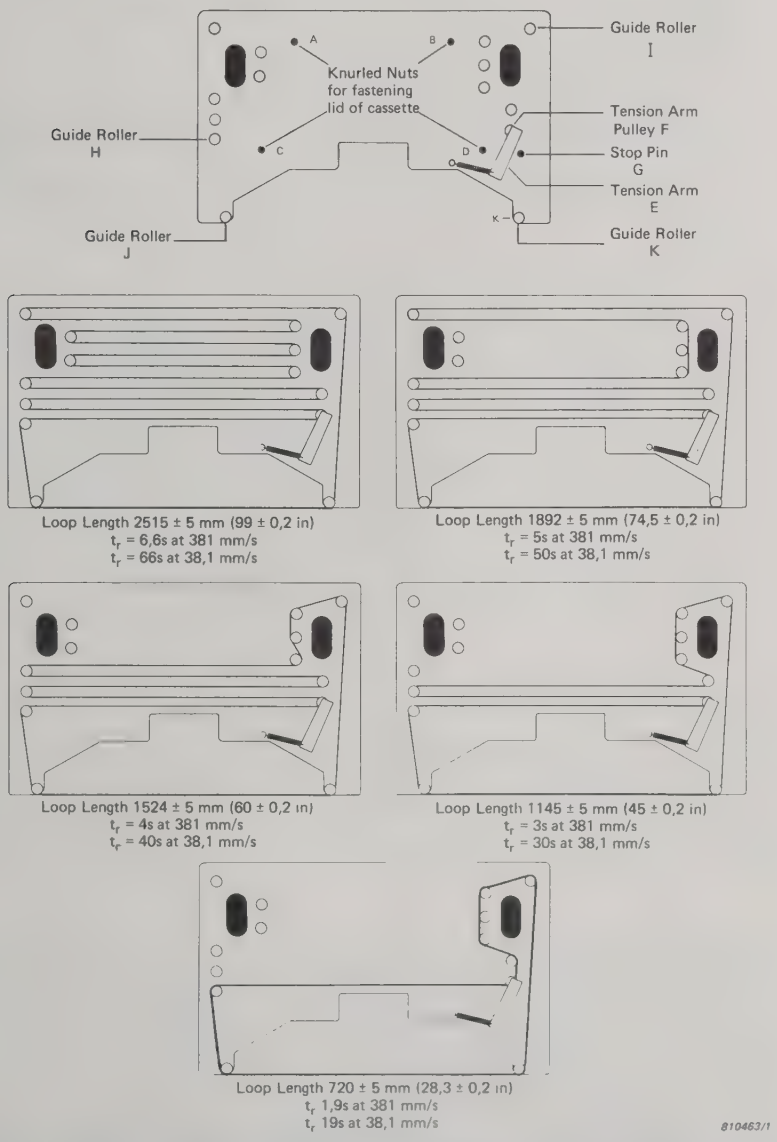

A
B
C
D
Knurled Nuts for fastening lid of cassette
Guide Roller I
Tension Arm Pulley F
Stop Pin G
Tension Arm E
Guide Roller K
Guide Roller H
Guide Roller J
Loop Length 2515 ± 5 mm (99 ± 0,2 in)
t_r = 6,6s at 381 mm/s
t_r = 66s at 38,1 mm/s
Loop Length 1892 ± 5 mm (74,5 ± 0,2 in)
t_r = 5s at 381 mm/s
t_r = 50s at 38,1 mm/s
Loop Length 1524 ± 5 mm (60 ± 0,2 in)
t_r = 4s at 381 mm/s
t_r = 40s at 38,1 mm/s
Loop Length 1145 ± 5 mm (45 ± 0,2 in)
t_r = 3s at 381 mm/s
t_r = 30s at 38,1 mm/s
Loop Length 720 ± 5 mm (28,3 ± 0,2 in)
t_r 1,9s at 381 mm/s
t_r 19s at 38,1 mm/s
B10463/1

Fig. 3.11. Tape threading patterns for fitting various lengths of tape loop to the Tape Loop Cassette UD 0035

2. Remove the tape loop already in the Cassette. To do this, place the Cassette so that its forked ends face forward and then slacken off the tension on the tape loop by pushing the tape tension arm "E" to the left. When the tape is completely slack and free of the tension arm guide roller "F", pull the tension arm up but not off its

locating pin, so that it clears the top edge of the tape. The tape loop may then be removed by carefully pulling it from under the tension arm and unthreading it from the guide rollers of the Cassette.

3. Take a fresh piece of recording tape, or the portion of tape on which the signal to be analyzed is recorded, and form it into a tape loop with one of the required lengths indicated in Fig. 3.11. For accurate cutting and splicing of the tape, a tape splicing machine should be employed together with a high grade adhesive splicing tape which has an optically reflective backing. Provided that the splicing tape does not exceed 20 mm in length, then its optically reflective backing may be used to trigger the marker function of the Recorder (see section 3.7).

4. Take one end of the tape loop and place it around the tension arm guide roller "F", so that the magnetic coating side of the tape is against the the roller.

5. Push the tension arm "E" to the left so that it clears the stop pin "G" and then push it down so that the bottom of the guide roller "F" just clears the base of the Cassette.

6. Starting from the tension arm guide roller "F", carefully thread one end of the tape loop around the guide roller "H" and then following the threading pattern appropriate to the length of loop, thread the other end of the loop up and around the guide roller "I". See Fig. 3.11.

7. Check that the tape is not twisted and that it sits correctly between the flanges of the tape guides before pulling it over the guide rollers "J" and "K". The magnetic coating of the portion of tape between the guide rollers "J" and "K" should now face forward and any slack in the tape should be taken up by the tension arm.

8. Finally replace the plastic cover of the Cassette.

3.6.3. Direct Mounting of Short Tape Loops

Where frequency analysis of extremely short duration events such as single shocks and impulses is of interest, it is necessary to convert them into a repetitive signal having a very short repetition time. For this purpose the recorded signal can be formed into a 415 $\pm$5 mm (16,4 $\pm$0,2 in) tape loop which may be fitted directly onto the Recorder as shown in Fig. 3.12.

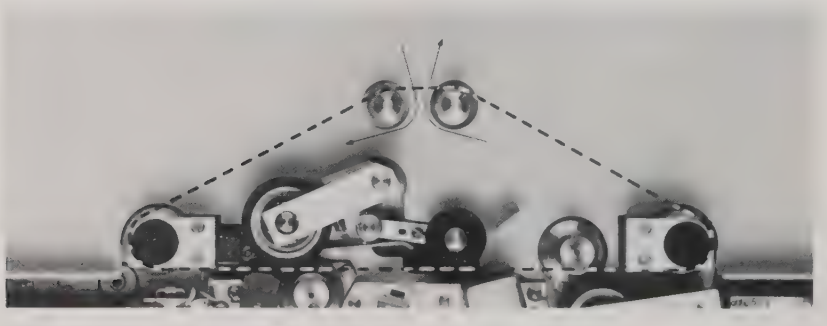


Fig. 3.12. Mounting of short tape loop directly onto the tape transport of a 7007

With a tape speed setting of 381 mm/s chosen for playback the above tape loop will give a signal repetition time of 1,1 s. The ±5 mm (±0,2 in) tolerance on the loop is necessary to keep the tape under tension outside the record/reproduce head path. For splicing the tape loop a professional tape splicing machine should be employed together with a high grade adhesive splicing tape. To facilitate triggering of the marker function of the Recorder, the splicing tape should have an optically reflective backing which should not exceed 20 mm (0,75 in) in length (see section 3.7).

3.7. AUTO–STOP AND TAPE MARKER FUNCTIONS

The 7007 incorporates a photoelectric tape sensor. This is mounted opposite the erase head and during operation with tape drive selected, serves to actuate the autostop function of the Recorder the moment either end of the recording tape passes outside the path of the record/reproduce heads. At the same time it automatically resets the Recorder to standby or returns the FAST FORWARD WIND–REWIND lever to its "O" power off setting.

A second means of actuating the autostop function is by marking the backing of the recording tape with a strip of optically reflective splicing tape which is at least 30 mm (1,2 in) long. With one of these marks included 3 m after the start and another 3 m before the end of the recording tape, the tape sensor can be made to actuate the autostop function so as to prevent the tape completely unwinding from the tape spools. Further, by marking the tape at the start of each recording, the autostop function may be used to facilitate fast location of the start of the individual recordings when "<<" or ">>" is selected with the FAST FORWARD WIND–REWIND lever.

On a similar basis marking or splicing with a strip of optically reflective tape not more than 20 mm (0,75 in) long, can be used to actuate a marker function. This momentarily shorts pin 3 with chassis pin 2 of the REMOTE 2 socket on the rear panel of the Recorder (see Fig. 2.4) and may be used to generate an electrical pulse which is useful for synchronizing external equipment when tape loop recorded data is frequency analyzed. For example, with a standard 8-way DIN cable AQ 0034 coupling the REMOTE 2 socket of the Recorder with the RECORDER CONTROL II socket of a B & K Octave and Third Octave Band Pass Filter Type 1617 or 1618, the marker may be employed to switch the Filter from one centre frequency to the next on each and every pass of the tape loop. Alternatively, utilising the connections shown in Fig. 3.13 the B & K Gauss Impulse Multiplier Type 5623 may be used in the analysis arrangement. This will prevent tape loop signal discontinuities and tape splice noise disturbing the analysis and enables analysis to be carried out using a Band Pass Filter with centre frequency which is swept or stepped by a Level or X-Y Recorder.

Note: The 7007 delays activation of the marker function, until the moment the marker splice passes the reproduce head.

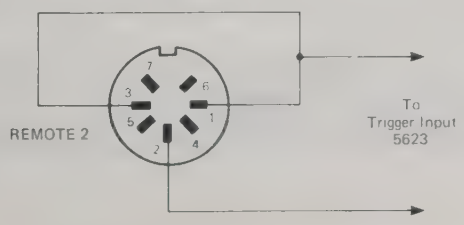


Fig. 3.13. The REMOTE 2 socket showing external connections for triggering the Gauss Impulse Multiplier Type 5623

3.8. ROUTINE MAINTENANCE

To keep the 7007 in peak operating condition, regular cleaning, as well as demagnetization of its record/reproduce heads is necessary. This should be carried out whenever the tape transport shows signs of contamination by dirt or loose ferrous oxide particles etc., and may be performed as follows:

1. Demagnetize the record, reproduce and erase head using an alternating magnetic field generated by a tape head demagnetizer or bulk tape eraser. When doing this it is important that the heads are first subjected to a slowly increasing field as the demagnetizer is moved towards them, and then to a slowly decreasing field as the demagnetizer is moved away. Sudden changes due to switching the demagnetizer on or off when close to the heads can leave them magnetized which will increase tape noise.

2. Clean the record, reproduce and erase head using a soft brush to remove loose dust and oxide particles and then wipe with the tip of a double ended cotton swab (ie., ear cleaning aid) which has been lightly dampened with head cleaning solvent. If dust and oxide particles are embedded on the heads, then this may be removed by gently rubbing with the plain wooden end of a match stick.

   WARNING! To prevent damage, avoid the use of metal tools and excessive amounts of solvent in contact with the heads. It is sufficient only to lightly dampen the tip of the cleaning swab.

3. Check that all tape guides as well as the capstans and the capstan pressure wheels are clean. If not, use the same procedure as outlined in item 2.

4. Wipe the entire tape compartment with a dry cloth and blow with a stream of compressed air to remove any remaining dust and oxide particles.

5. To remove grease and dirt from the tape compartment lid, wipe with a soft cloth which has been dampened in water with few drops of mild soap solution added. To finish, polish with a dry cloth.

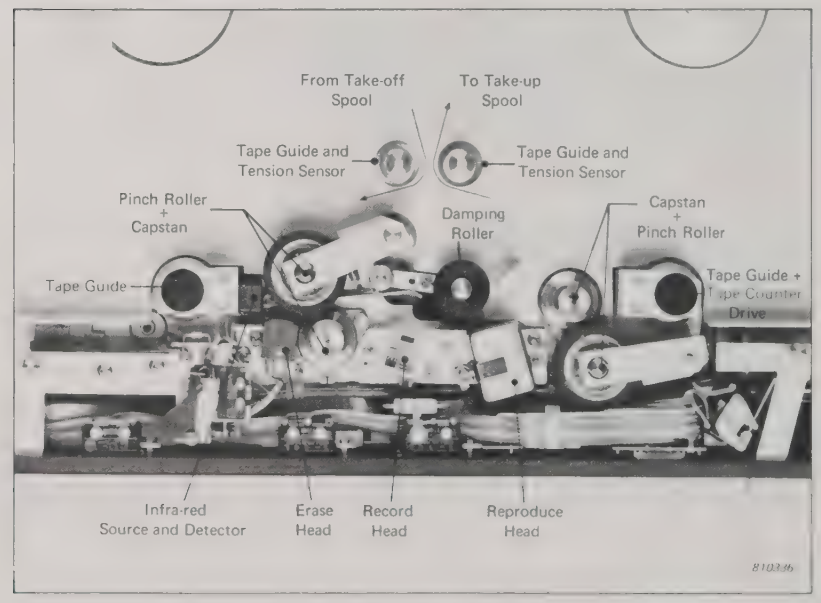


Fig. 3.14. View of tape compartment showing parts to be cleaned for maintaining the Recorder in peak operating condition

4. OPERATION

Operation in this Chapter concentrates on the use of Tape Recorder Type 7007 together with four Vibration Units ZM 0060 plus an optional Two Channel Compander Unit ZM 0054. The same basic considerations also apply for operation of the Vibration Units with the B & K Tape Recorders Type 7005 and 7006. For details on the use of the FM and Direct Units ZM 0299 and ZM 0053 with the 7007, the Instruction Manual for the 7005/7006 should be consulted.

4.1. PRELIMINARY CALIBRATION

Calibration of the 7007 for operation with the Vibration Units ZM 0060 exhibits excellent long term stability. Therefore, once correctly calibrated, no further calibration adjustments are normally required. However, it is generally good measurement practice to check their calibration prior to each daily use. The calibration check and adjustment procedure is as follows, and may be carried out without a spool of recording tape fitted.

1. Set the STAND BY lever to "Drive Pos." and using the MONITOR SWITCH select the "Supply" check mode. Depending on whether the plug-in battery pack or another supply is used, the meter pointer should deflect to the centre of the "Batt." or "Supply" range of the meter scale. If the meter pointer lies outside or only just inside the appropriate scale range, then the Battery Pack or supply should be replaced or charged. See section 3.4.

2. Keeping the STAND BY lever set to "Drive Pos.", set the MONITOR SWITCH to one of the channels containing a Vibration Unit ZM 0060.

3. On the Vibration Unit of the selected channel, set the RANGE control to "10 000 mV/Unit" and screen its INPUT socket using one of the TNC to 10-32 UNF Adaptors JP 0162 and Screening Caps YM 0420 provided.

4. Set the MODE switch of the Vibration Unit to "Cal.1" and "Cal.2" respectively, and check that a pointer indication close to -∞ is obtained on the meter. If not, use the CAL.1 and CAL.2 potentiometers to adjust the balance of the reproduce section demodulator and record section modulator until minimum pointer deflection is obtained.

5. Set the MODE SWITCH to "Ref." to connect the internal 1 kHz reference signal to the Vibration Unit. With the RANGE potentiometer set as in item 3, a pointer indication corresponding with approximately "0" dB should be obtained on the meter. If not, internal adjustment of the Vibration Unit will be required. see separate Service Instruction Manual for ZM 0060.

6. Repeat items 2 to 5 for each of the remaining channels fitted with a ZM 0060 and finally press the RELEASE button to disconnect power from the Recorder.

4.2. RECORDING VIBRATION MEASUREMENTS

For recording acceleration and velocity measurements with the 7007 the use of the B & K Uni–Gain® Accelerometers Types 4371 and 4384 are recommended. These are an equivalent pair and are furnished with side and top mounted outputs respectively. Both have a Uni-Gain charge sensitivity of 1 pC/ms^{-2} (±2%) which depending on the RANGE setting of the Vibration Units ZM 0060 enable vibration levels up to 1000 m/s^{2} or mm/s^{-1} to be recorded (see Table 4.1). With stud mounting of the 4371 and 4384, the typical record-reproduce frequence response obtained with ZM 0060 is from 0,3 Hz up to 20 kHz (±3 dB).

Range (mV/vibration unit)		1	3,16	10	31,6	100	316	1000	3160	10000
Uni-Gain® Accelerometer Types 4371 & 4384 (1 pC/ms^{-2})	Acc. Mode	1 Kms^{-2}	316 ms^{-2}	100 ms^{-2}	31,6 ms^{-2}	10 ms^{-2}	3,16 ms^{-2}	1 ms^{-2}	316 mms^{-2}	100 mms^{-2}
	Vel. Mode	1 ms^{-1}	316 mms^{-1}	100 mms^{-1}	31,6 mms^{-1}	10 mms^{-1}	3,16 mms^{-1}	1 mms^{-1}	316 μms^{-1}	100 μms^{-1}
Uni-Gain® Accelerometer Types 4370 & 4381 (10 pC/ms^{-2})	Acc. Mode	100 ms^{-2}	31,6 ms^{-2}	10 ms^{-2}	3,16 ms^{-2}	1 ms^{-2}	316 mms^{-2}	100 mms^{-2}	316 mms^{-2}	10 mms^{-2}
	Vel. Mode	100 mms^{-1}	31,6 mms^{-1}	10 mms^{-1}	3,16 mms^{-1}	1 mms^{-1}	316 μms^{-1}	100 μms^{-1}	31,6 μms^{-1}	10 μms^{-1}
Overall Record–Reproduce Sensitivity (mV/pC)		1	3,16	10	31,6	100	316	1000	3160	10000

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Table 4.1. Vibration levels required to produce "0" dB nominal record-reproduce level with different RANGE settings of the Vibration Unit ZM 0060 when using B & K Uni-Gain® Accelerometers 4371 and 4384 or 4370 and 4381

If required other Uni-Gain or non Uni-Gain Accelerometers may be employed. However, in this case an appropriate sensitivity correction factor must be employed or a reference vibration level recorded on tape to facilitate determination of recorded signal levels on playback. Also the useful operating frequency range of the accelerometer must be taken into account. If this is less than the record-reproduce frequency response of the Vibration Unit then the accelerometer should be mounted using a Mechanical Filter UA 0559 to prevent its mounted resonance frequency influencing recorded measurements.

To record acceleration and velocity measurements, proceed as follows:

1. Fit the Recorder with a spool of recording tape and calibrate the respective Vibration Units to be used for recording measurements. See sections 3.6 and 4.1 respectively.

2. Locate a suitable portion of the tape for recording measurements. It is important that this does not contain previously recorded data of interest as this will be automatically erased by the particular Vibration Units selected for recording regardless of whether the ERASE switch is set to "Off" or not.

3. Mount one or more piezoelectric accelerometers to the machine or structure whose vibration is to be recorded. See the B & K "Piezoelectric Accelerometer and Vibration Preamplifier" Handbook for details of approved types of mounting.

4. Couple the accelerometers to the INPUT sockets of the respective Vibration Units in the Tape Recorder using the TNC connectors JP 0152 or TNC to 10–32 UNF Adaptors JP 0162 provided. If necessary several hundred metres of low-noise tranducer cable can be employed without it influencing the overall sensitivity of the Accelerometers and Vibration Units.

5. Using the small pull-out screwdriver provided, set the LLF switch of the Vibration Units to a suitable –3 dB lower limiting frequency which will exclude influence of temperature fluctuations on the transducer. When using B & K Accelerometers Types 4370, 4371, 4381 or 4384, operation with an 0,3 Hz low frequency cutoff is normally possible because of their low temperature transient sensitivity.

6. Set the MODE SWITCH of the Vibration Units to be used for recording to their "Acc.–m/s^2" or "Vel.–mm/s" record mode and the MODE SWITCH of the other units to "Rec. Off".

7. Set the STAND BY lever to "Drive Pos." and select a TAPE SPEED setting of "38,1" or "381" mm/s in accordance with the particular frequency response required for recording. See Chapter 5.

8. Start vibration of the machine or structure and using the MONITOR SWITCH to select the required channel, monitor the peak record level of one of the Vibration Units selected for recording.

   For the majority of signal peaks the meter deflection on the Recorder should not exceed the "0" dB nominal record level indicated on the meter. However, occassional signal peaks giving deflections up to but not exceedingly "+3" dB on the meter may be tolerated without causing overload.

9. If the meter deflection is more than 10 dB below or 3 dB above the "0" dB nominal record level step the input RANGE switch of the particular Vibration Unit selected until a suitable record level indication is obtained.

10. Repeat items 8 and 9 to obtain a suitable record level indication with the other Vibration Units selected for recording.

11. Note the TAPE COUNTER reading for subsequent location of the start of recorded data when playback is required.

12. To start recording, press the RECORD button and whilst keeping it depressed, press the DRIVE button. The TAPE SPEED LED will be momentarily extinguished and then relit when the recorder has locked onto the correct tape speed.

13. To stop recording, press either the STOP or RELEASE button. Use of the STOP button returns the Recorder to its stand by mode, while the RELEASE button sets the STANDBY lever to "Off", disconnecting power from the Recorder.

14. Note the following for future reference:

    - Type of signal recorded plus charge sensitivity of the particular accelerometer employed.
    - TAPE COUNTER reading at the start and finish of the recording.
    - The particular channels plus associated Vibration Units employed.
    - The RANGE and MODE SWITCH setting of each unit

4.3. RECORDING OF ON–TAPE MEASUREMENT REFERENCE

Use of an on-tape measurement reference is not strictly necessary with the 7007. Provided that the Uni–Gain® Accelerometer plus RANGE setting used for recording is known, then the vibration level corresponding to an output level of 1 V RMS may be determined from Table 4.1 with accuracy of ±2 %. Nevertheless, it is useful for accurate determination of recorded levels when non uni-gain accelerometers are employed with the Recorder and permits precise adjustment of measurement equipment used for subsequent analysis of recorded measurements.

To record either the internal 1 kHz reference or an external reference source, proceed as follows:

1. Set the STAND BY lever to "Drive Pos.", and using the MONITOR SWITCH select one of the channels used for recording measurements.

2. Apply the reference signal to the selected channel so as to obtain an on-scale record level indication on the Recorders meter. The type of reference signal and the method of application is as described in section 4.3.1 or 4.3.2.

3. Select a suitable TAPE SPEED setting and note the TAPE COUNTER indication for location of the recorded reference on playback.

4. To record the reference, press the RECORD button and whilst keeping it depressed, press the DRIVE button. After recording the reference for approximately 1 minute, press the STOP or RELEASE button to stop recording.

5. Note the following for future reference:

   - Equivalent level of the recorded reference, determined in section 4.3.1 or 4.3.2.

   - TAPE COUNTER reading at the start and finish of the recording.

6. Repeat items 2 to 6 for the other channels used for recording measurements.

7. Finally press the RELEASE button to disconnect power from the Recorder and set the MODE SWITCH of the respective Vibration Units to "Rec. Off".

4.3.1. Internal 1 kHz Reference Source

This is connected by setting the MODE SWITCH of the selected channel to "Ref". For recording set the RANGE switch to "10 000 mV/Unit" and screen the INPUT of the vibration Unit using one of the TNC to 10-32 UNF Adaptors JP 0162 and Screening Caps YM 0420 provided. On playback, the equivalent velocity or acceleration level of the recorded reference will depend on the particular Uni–Gain® accelerometer sensitivity and RANGE setting used for recording measurements. The relevant velocity and acceleration levels are listed under the RANGE settings for a "0 dB" nominal record level in Table 4.1. If for example a RANGE setting of "1000" mV/unit is used and acceleration signals are being monitored, then the recorded reference level will be equivalent to 1 ms^{2} for a 1 pC/ms^{-2} Uni-Gain® Accelerometer and 100 mms^{-2} for a 10 pC/ms^{-2} one.

If an accelerometer with a non uni-gain sensitivity is employed for measurements then the equivalent velocity or acceleration level of the recorded reference may be quickly determined by dividing the level specified for a 1 pC/ms^{-2} Uni–Gain® Accelerometer in Table 4.1. by the sensitivity of the non uni-gain accelerometer.

4.3.2. Accelerometer Calibrators Type 4291 and 4294

For recording a vibration measurement reference, either the portable Accelerometer Calibrator Type 4291 or the hand-held Calibration Exciter Type 4294 may be used. Both Calibrators have built-in vibration tables on which a piezoelectric accelerometer or other types of vibration measurement transducer may be mounted. The 4291 may be adjusted to produce an acceleration reference level of 7,07 ms^{-2} RMS with corresponding velocity level of 14,14 mm/s, whereas the 4294 is designed to produce a reference acceleration level of 10 ms^{-2} RMS with a corresponding velocity level of 10 mm/s. For recording the reference, select a RANGE setting on the Vibration Unit ZM 0060, so that a record level indication not exceeding +3 dB is obtained on the Recorder. On playback the equivalent vibration level of the recorded reference will correspond to:

$$A_{eq} = \frac{A_s\, A_m}{A_r}$$

where
A_{eq} is the equivalent vibration level (ms^{-2} or ms^{-1}) of the reference on playback.
A_s is the vibration level (ms^{-2} or ms^{-1}) generated by the reference source.
A_m is the "mV/Unit" RANGE setting chosen for recording measurements.
A_r is the "mV/Unit" RANGE setting chosen for recording the measurement reference.

4.4. REPRODUCTION OF RECORDED MEASUREMENTS

For playback of recorded measurements, plus calibration of associated equipment to be used for measurement and analysis of reproduced data, proceed as follows:

1. Fit the spool of recording tape containing the recorded data to be measured or analyzed, and manually wind on approximately 15 turns of tape onto the empty tape spool. See section 3.6.1.

2. Press the TAPE COUNTER RESET button to set the counter indication to "000" and if stop tape is not fitted, set the ZERO STOP switch to "On".

3. Check the calibration of the particular ZM 0060 Vibration Units to be used for playback of the recorded data (see section 4.1). For playback of data immediately after recording, calibration can be ignored.

4. Set the MODE SWITCH of the Vibration Units to "Rec. Off" and using the MONITOR SWITCH select the particular channel required for playback of the recorded data.

5. Locate the portion of tape on which the measurement reference was recorded. To do this set the FAST FORWARD WIND–REWIND lever to ">>" and monitor the TAPE COUNTER reading. When the counter registers the value corresponding to the start of the measurement reference, press the STOP button to stop the tape drive.

6. Connect the OUTPUT socket of the ZM 0060 Vibration Unit of the particular channel selected to the DIRECT INPUT socket of a Measuring Amplifier or Frequency Analyzer. Also fit the Measuring Amplifier or Frequency Analyzer with a voltage or vibration measurement scale.

7. Set the STAND BY lever of the Recorder to "Drive Pos." and select the TAPE SPEED setting used for recording the measurement reference.

8. Press the DRIVE button to start playback of the reference signal and step the INPUT SECTION GAIN of the Measuring Amplifier or Frequency Analyzer to obtain an on-scale meter indication on the instrument. The approximate output voltage level for "0" dB nominal reproduce level is 1 V RMS - 1,41 V Peak.

9. Adjust the input sensitivity of the Measuring Amplifier or Frequency Analyzer to obtain a meter indication corresponding to the equivalent vibration level (acceleration or velocity) of the reference signal. See section 4.3.1 or 4.3.2.

10. Once the Measuring Amplifier or Frequency Analyzer has been correctly adjusted, press the RELEASE button of the Recorder to stop playback of the recorded reference.

11. Using the FAST FORWARD WIND–REWIND lever, select "<<" and locate the portion of tape on which the data to be measured or analyzed is recorded. To stop the tape drive, press the STOP button.

12. If the recorded data is too short to be analyzed as a continuous signal, then form it into a tape loop for playback as a repetitive signal. Tape loops may be fitted to the Recorder as described in section 3.6.

13. Set the STAND BY lever to "Drive Pos." and press the DRIVE button to start playback and commence measurement or analysis of the recorded data.

14. To stop playback, press either the STOP or RELEASE button. Use of the STOP button returns the Recorder to its stand by mode, while the RELEASE button sets the STANDBY lever to "Off", disconnecting power from the Recorder.

4.5. USE WITH TWO CHANNEL COMPANDER UNIT ZM 0054

The Compander Unit ZM 0054 is primarily designed for use with the FM and Direct Units ZM 0053 and ZE 0299. However, it may also be employed with the Vibration Units ZM 0060 when these are installed channels in Ch-3 and Ch-4. In this connection the Compander is of benefit for application of acoustic and voltage signals to the Vibration

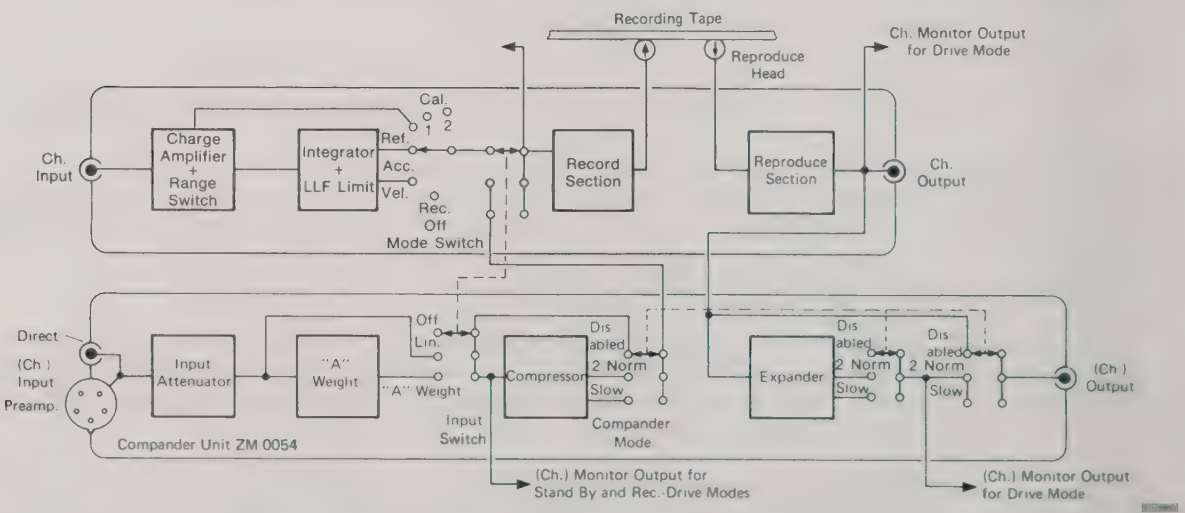

Fig. 4.1. Simplified block diagram showing internal coupling of one of the Two Channel Compander channels with a Vibration Unit

Units and when employed with automatic gain regulation permits two separate non stationary signals (i.e. signals of changing level) having a dynamic range of over 70 dB to be recorded and reproduced.

For application of stationary signals (i.e. signals of relatively constant level) or use of the Compander without automatic gain regulation, the dynamic range is limited by the signal-to-noise ratio of the Vibration Units which is 40 to 45 dB depending on the particular tape speed setting chosen.

To aid explanation of the use of the Compander with the Vibration Units, reference is made to the block diagram shown in Fig. 4.1.

Note: When using the Compander a maximum of four FM and Direct Units or two Vibration Units together with two Direct Units or one FM Unit may be employed on account of the power consumption of the various units.

4.5.1. Use of Direct and Preamp. Inputs

Both channels of the Compander are furnished with two alternative AC coupled inputs – a DIRECT INPUT for application of voltage signals and a PREAMP. INPUT for connection of 1/2-inch Microphones via a B & K Microphone Preamplifier Type 2642. Besides serving as a signal input, the PREAMP. INPUTs provide stabilized voltages necessary for operation of microphone preamplifiers and associated microphones. For use with condenser microphones either +28 V or +200 V polarisation may be chosen using the POL. VOLT. switch located on the rear of the Compander Unit. In addition, a 0 V setting is available for use with prepolarized types of microphone.

Whilst recording with a microphone and preamplifier combination connected, it is recommended that the MONITOR LEVEL knob is set to its extreme anticlockwise position. This is necessary to prevent disturbance by the built-in loudspeaker and is especially important when operating the Compander in circuit, as its wide range of automatic gain regulation makes it especially sensitive to acoustic feedback.

WARNING: To prevent damage to a preamplifier make sure that it is fitted with a microphone before connecting it to one of the PREAMP. INPUT sockets of the Compander. Also always check that the POL. VOLT switch on the rear of the Compander is set to provide the appropriate polarization voltage for the microphone (see microphone calibration chart). Application of a polarization voltage exceeding the recommended level will not damage a microphone, but will make it inoperative for 10 or 15 minutes after the correct polarization voltage has been selected.

4.5.2. Use without Automatic Gain Regulation

For use of the Compander as a two channel microphone power supply without automatic gain regulation, connect each of the PREAMP. INPUT sockets with a suitable Microphone and Preamplifier combination and set the COMPANDER MODE switch to "Disabled" plus the INPUT SWITCH to either "Lin." or "A-weight". This couples the record sections of the Vibration Units of Ch-3 and Ch-4 with the input attenuator (and if selected, A-weighting) sections of the Compander. In addition it isolates the charge amplifier and integrator section of the Vibration Units from their record sections and lights the INT. INPUT LEDs on their front panels.

To commence recording of sound levels with the Compander coupled in circuit as described above, set the MODE SWITCH of the Vibration Units of Ch-3 and Ch-4 to

"Acc." and select the RECORD–DRIVE mode. The record level may be set using the INPUT ATT. switches of the Compander and can be monitored on the meter when the MONITOR SWITCH is set to "(Ch-3)" or "(Ch-4)". When using the "0,1 V" INPUT ATT. setting and a Microphone and Preamplifier having a nominal sensitivity of 50 mV/Pa, a "0" dB record level indication on the meter will correspond to a sound pressure level of approximately 100 dB re 20 μPa.

With regard to recording of voltage signals via the DIRECT INPUT of the Compander, the "0,1 V", "1 V" and "10 V" INPUT ATT. settings denote the input voltage levels required to produce 0 dB nominal record level indication with the Recorder.

4.5.3. Use with Automatic Gain Regulation

This mode of operation is useful for unattended recording and enables non stationary (ie signals with changing level) with dynamic range of over 70 dB to be recorded and reproduced. It is selected by setting the COMPANDER MODE switch to "Normal" and the INPUT SWITCH to its "Lin." or "A-weight" setting. This internally connects the record-reproduce sections of the Vibration Units of Ch-3 and Ch-4 with the compressor and expander sections of the Compander (see Fig. 4.1). At the same time it isolates the charge amplifier and integrator sections of the Vibration Units from their record sections and lights the INT. INPUT LEDs on their front panels.

For recording with the Compander in circuit, the MODE SWITCH of the Vibration Units should be set to "Acc.". The input signal level may be attenuated in 20 dB steps using the INPUT ATT. switches of the Compander and can be seen on the meter when the MONITOR SWITCH is set to "(Ch-3)" and "(Ch-4)" respectively. As the Compander automatically regulates the input section gain to suit the average level of the input signal, any record level indication between -20 dB and +3 dB is suitable for recording. The "0,1 V", "1 V" and "10 V" INPUT ATT. settings of the Compander, denote the input voltage levels required to produce 0 dB nominal record level indication on the meter. With a microphone of nominal sensitivity of 50 mV/Pa connected the corresponding sound pressure levels required to produce 0 dB nominal record level are approximately 100, 120 and 140 dB re 20μPa respectively.

It should be noted that operation of the Compander with automatic gain regulation, modifies the overall frequency response of the Vibration Units (see section 5.2.1). With regard to making time and frequency transformations using different tape speed settings for recording and reproduction of data, the COMPANDER MODE "Slow" and "Normal" settings should be reserved for operation at 38,1 and 381 mm/s respectively. The maximum rate of automatic gain regulation with these settings is 20 and 200 dB/s respectively. **Consequently when time and frequency transformation of recorded data is not required, it is best that the COMPANDER MODE switch be kept set to "Normal" for operation with either tape speed setting.** Signals with rise times exceeding the maximum rate of gain regulation will cause the OVERLOAD LEDs of the Compander to light.

Note: The Compander is well suited for recording aircraft take-off and flyover noise, vehicle passby noise etc. For recording signals of an impulsive or transient nature, however, its use without automatic gain regulation is recommended.

4.5.4. Calibration and Recording of On-Tape Reference

Other than the normal calibration adjustments necessary for operation of the Vibration Units (see section 4.1), no further adjustment is required for use with the Compander.

However, to aid accurate determination of recorded signal levels and facilitate adjustment of associated measuring and analyzing equipment on playback, it is recommended that a reference level be recorded on tape. For this purpose it is generally simplest to use an external source such as a Pistonphone or Sound Level Calibrator as a sound level reference, and the internal 1 kHz source as a voltage level reference.

For recording the two types of reference, leave Compander set as for recording measurements. The sound level reference may then be recorded by fitting the Pistonphone or Sound level Calibrator over the microphone, while the internal reference may be recorded by setting the MODE and RANGE switches of the Vibration Units used with the Compander to "Ref." and 10000 mV/Unit" respectively. In the latter case selection of "Ref." automatically disconnects the input section of the Compander from the Vibration Units and reconnects their charge amplifiers. Consequently for monitoring the level of the internal reference during recording the MONITOR SWITCH of the Recorder should be set to either "Ch-3" or "Ch-4" (see section 4.6).

On playback the recorded reference will be equivalent to the sound pressure level generated by the Pistonphone or Sound Level Calibrator, or the voltage setting to which the INPUT ATT. of the Compander was set for measurements.

4.5.5. Reproduction of Measurements

For reproduction of measurements and reference levels recorded via the Compander, the same INPUT SWITCH and COMPANDER MODE settings as used for recording should be employed. Whereas the recordings made without automatic gain regulation may be reproduced either via (Ch-3) and (Ch-4) OUTPUT sockets of the Compander or via the OUTPUT sockets of the Vibration Units used with channels Ch-3 and Ch-4, those made with automatic gain regulation must be reproduced via the OUTPUT sockets of the Compander. This is on account that companded signals must first be expanded by the Compander in order to restore them to their original form.

On playback of data, the output level corresponding to the 0 dB nominal reproduce level will be equivalent to the particular INPUT ATT. setting used for recording. However, the absolute output voltage level corresponding to the 0 dB nominal reproduce level will always be approximately 1 V RMS - 1,41 V Peak.

4.6. MONITORING OF RECORDED SIGNALS

Using the MONITOR SWITCH on the front panel, the respective Vibration Units of channels Ch-1 to Ch-4 may be selected in turn for monitoring via the built-in meter and

Vibration Unit MODE SWITCH setting	7007 (or 7005/6) Operating Mode		
	Stand By	Record	Drive — Reproduce
"Rec. Off"	—	Ch — Output	Ch — Output
"Acc." or "Vel."	Ch — Input	Ch — Input	Ch — Output
"Ref."	1 kHz Ref. Output	1 kHz Ref. Output	Ch — Output
"Cal. 1" or "Cal. 2"	Carrier Ref. Output	Carrier Ref. Output	Ch — Output

Table 4.2. Inputs and outputs selected for monitoring via the built-in meter and loudspeaker when the MONITOR SWITCH is set to channel Ch-1, Ch-2, Ch-3 or Ch-4 which includes a Vibration Unit ZM 0060

loudspeaker of the Recorder. As indicated in Table 4.2 either the record section input or the reproduce section output of the selected channel may be monitored depending on the particular operating mode selected. When the Vibration Units installed in channels Ch-3 and Ch-4 are coupled with the Two Channel Compander Unit, the MONITOR SWITCH positions Ch-3 and (Ch-3) plus Ch-4 and (Ch-4) are used. In this case the inputs and outputs monitored are as indicated in Table 4.3.

7007 (or 7005/6) Operating Mode		Stand By		Record		Drive – Reproduce	
METER SWITCH setting		Ch –	(Ch –)	Ch –	(Ch –)	Ch –	(Ch –)
COMPANDER Mode Switch setting	"Disable"	Ch Input via (Ch) Input	(Ch) Input	Ch Input via (Ch) Input	(Ch) Input	Ch Output	Not Applicable
	"Normal" or "Slow"	Compressed Input to Ch via (Ch)	(Ch) Input	Compressed Input to Ch via (Ch)	(Ch) Input	Compressed Output from Ch to (Ch)	Expanded Output from (Ch)

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Table 4.3. Inputs and outputs selected for monitoring via the built-in meter and loudspeaker when the Two Channel Compander Unit ZM 0054 is employed with channels Ch-3 and Ch-4 and the MONITOR SWITCH is set to Ch-3 and (Ch-3) or Ch-4 and (Ch-4)

4.7. USE WITH FM FLUTTER COMPENSATION

Supplementing servo control of the differential capstan drive of the Recorders, is a flutter compensation mode. This may be utilized when Ch-2 and at least one other channel are equipped with Vibration (or FM) Units and may be chosen by setting the FM FLUTTER COMPENSATION switch to "On". With the RECORD–DRIVE mode selected and the MODE SWITCH of the Vibration Units set to either "Acc." or "Vel." ("AC" or "DC" with the FM Units) it records a fixed frequency internal reference on tape via channel Ch-2 while measurements are recorded via the other channels. On subsequent playback it applies the recorded reference to the other Vibration (or FM) Units where the instantaneous frequency of the reference is used to automatically correct reproduce signal amplitudes for recorded flutter components. In this way the effect of recorded flutter due to external movement and vibration of the Recorder is reduced by as much as 35 dB at frequencies up to 500 Hz (see section 5.2.4).

Whilst operating with flutter compensation selected, the INT. INPUT LED on the front of the Vibration (or FM) Unit included with channel Ch-2 will be lit. In addition the input section of the Unit will be internally disconnected from the record section to prevent interference from external signals applied via the INPUT socket of the Unit. It should be noted that there is no benefit to be gained from using the flutter compensation mode for playback, without first having used it for recording a flutter compensation reference. For playback of recordings which lack a recorded reference, the Recorders will automatically select an internal fixed frequency reference so that flutter compensation does not take place.

4.8. USE OF VOICE MICROPHONE

For recording comments on measurement and tape identities a Dynamic Microphone MM 0021 is supplied. This connects to the VOICE MIC. socket on the front panel of the 7007 and has an integral switch for activating a voice amplifier circuit in the Recorder. When set to "On", the voice amplifier is coupled to the record section of the Vibration Unit (or optional FM or Direct Unit) employed with channel Ch-1. At the same time the

INT. INPUT LED on the front of the unit is lit and its INPUT socket, RANGE or INPUT ATT. switch etc. isolated from the record section, thus making channel Ch-1 ready for recording comments when the MODE SWITCH of the unit is set to "Acc." or "Vel." ("AC" or "DC" with the FM or Direct Units) and the RECORD – DRIVE mode is selected. The level at which comments are recorded may be adjusted by altering the relative position of the microphone with respect to the user and can be seen on the meter when the MONITOR SWITCH is set to "Ch-1".

WARNING! Before using Ch-1 voice channel, check that the portion of tape on which comments are to be recorded is free of recorded measurements and that the full track ERASE switch of the Recorder plus the MODE SWITCH of the FM, Direct or Vibration Units used with Ch-2, Ch-3 and Ch-4 are set to "Rec. Off". Failure to carry out these checks can result in erasure of previously recorded data.

4.9. REMOTE CONTROL

For remote push-key selection of the RECORD, DRIVE and STOP functions of the 7007, the Remote Control Unit WB 0702 may be obtained on special order. This comes equipped with a 3,5 m long connection cable WL 0111 for coupling it to the REMOTE 1 socket of the Recorder and for a remote indication of which particular function is selected as well as when the 7007 has locked onto the correct tape speed, each of its push-keys is furnished with an indicating LED. In order that remote control may be exercised using the Control Unit, the STAND BY lever of the Recorder must first be set to "Drive Pos.". If a connection cable longer than 3,5 m is required, then this should be specified when ordering WB 0702.

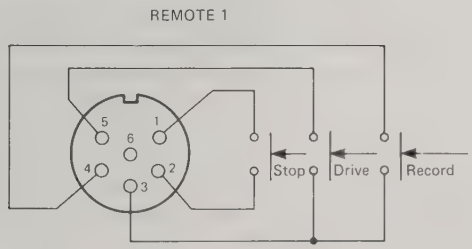


Fig. 4.2. Push-key switch arrangement for remote selection of the RECORD, DRIVE and STOP functions via the REMOTE 1 socket of the 7007. (External view of socket or soldering side of connecting plug shown)

Where remote control without a remote indication is considered sufficient, one of the simple switching arrangements shown in Figs. 4.2 and 4.3 may be used instead of WB 0702. These may be made up by the user and utilize self-resetting push-key switches which may be connected to the REMOTE 1 socket using the 6-pin plug (B&K no. JP 0601) provided. With the arrangement in Fig. 4.2 the RECORD, DRIVE and STOP functions may be selected in the same manner as with the push buttons on the Recorder, whilst with that in Fig. 4.3 immediate change over from RECORD to DRIVE (and vice versa) is possible without having to first select STOP. As with the Control Unit WB 0702, the STAND BY lever of the Recorder must first be set to its "Drive Pos.", to permit remote control.

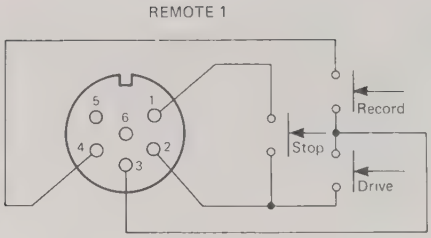


Fig. 4.3. Push-key switch arrangement for remote selection of "flying" RECORD—DRIVE functions via the REMOTE 1 socket of the 7007. (External view of socket or soldering side of connecting plug shown)

5. CHARACTERISTICS

5.1. TAPE TRANSPORT

5.1.1. Tape Speeds

The "38,1" and "381" mm/s tape speed settings of the 7007 are controlled electronically and are accurate to within ±0,25%. This is accomplished using a sensitive servo amplifier system to regulate the operating speed of the tape transport drive motor, which for precise control is phase locked to a reference frequency derived from an internal quartz crystal oscillator. For optimal reliability, electronic frequency dividers are incorporated to effect a change in tape speed setting, thus eliminating the need of shifting belts and pulleys for this purpose.

5.1.2. Flutter

Flutter is a form of undesired frequency modulation in a recorded signal and is caused by irregular motion of the tape during recording or reproduction. From the values specified in Table 5.1 it can be seen that with the 7007 this form of distortion has been kept low. This can be attributed to its low mass, differential capstan drive which is used to maintain accurate and stable tape speeds even under severe operating conditions where the Recorder is subjected to external motion and vibration.

Table 5.1 gives both weighted and cumulative values of flutter. These are measured in accordance with the German DIN standard 45 507 (October 1967) and the American IRIG standards 106.66 to 77 respectively. Whereas DIN specify use of a special frequency weighting characteristic to obtain an objective indication of the audible effects of flutter, IRIG specify that cumulative flutter is measured using a flat frequency characteristic which takes into acount both audible and inaudible flutter components. As a result flutter values measured to IRIG are somewhat higher than the DIN values and in general give a more precise indication of the actual amount of flutter produced.

Tape Speed	Cumulative Peak-Peak (IRIG 106.66-77)	Weighted Flutter (DIN 45-507)
38,1 mm/s	< 0,7% (0,5 to 313 Hz)	< 0,1%
381 mm/s	< 0,5% (0,5 Hz to 2,5 kHz)	< 0,06%

810697

Table. 5.1. Cumulative and weighted flutter produced by the 7007

5.2. VIBRATION UNIT ZM 0060

The Vibration Unit ZM 0060 is similar to the FM Unit ZM 0053 in that it utilizes the Group 1, Wide Band FM Record technique laid down by the American IRIG Standards 106.66 to 106.77. This gives benefits of a good low frequency amplitude response plus excellent

amplitude stability independent of the magnetization level and storage characteristics of the magnetic recording tape.

Combined with the fact that ZM 0060 is equipped with a charge amplifier input stage this makes it ideal for recording a wide variety of vibration signals including mechanical shock where good waveform preservation plus accurate reproduction signal levels are required for laboratory measurements and frequency analysis.

5.2.1. Input Characteristics

Signal conditioning with the Vibration Units is based on use of B & K Uni-Gain® Accelerometers having a charge sensitivity of 1pC/ms^{-2}. Using the RANGE switch of the Vibration Units, the sensitivity of the charge amplifier may be stepped to produce calibrated record-reproduce sensitivity settings between 1 and 10000 mV/pC or mV/vibration unit which are selectable in accurate 10 ($\pm$0,1) dB steps. When other types of accelerometer are employed the overall record-reproduce sensitivity can be determined by multiplying the RANGE setting by the specified charge sensitivity of the transducer.

Because of the charge amplifier input, no external preamplifier instrumentation is required for connection of Accelerometers to the Vibration Units. Also low-noise transducer cables up to 300 metres in length with nominal capacitance of 90 pF/m may be employed for coupling Accelerometers. Provided that cable capacitance is less than 30 nF then its influence on the overall sensitivity of Accelerometer and Recorder is insignificant. Determination of the system sensitivity is thus greatly simplified as the charge sensitivity of the accelerometer is always that stated on its calibration chart. However, care should be taken when using long cables as their capacitance will reduce the signal-to-noise ratio of the Vibration Units (see section 5.2.5).

5.2.2. Frequency Response

The typical record-reproduce frequency response of the Vibration Units ZM 0060 is shown in Fig. 5.1. With the "Acc." MODE SWITCH setting a linear response is obtained. At low frequencies the response depends on a high-pass filter built around the input stage of the record section. This may be switch using the LLF switch to provide –3 dB lower limiting frequencies of 0,3; 1 and 10 Hz which are useful for excluding unwanted low frequency noise such as generated by some types of transducer when exposed to

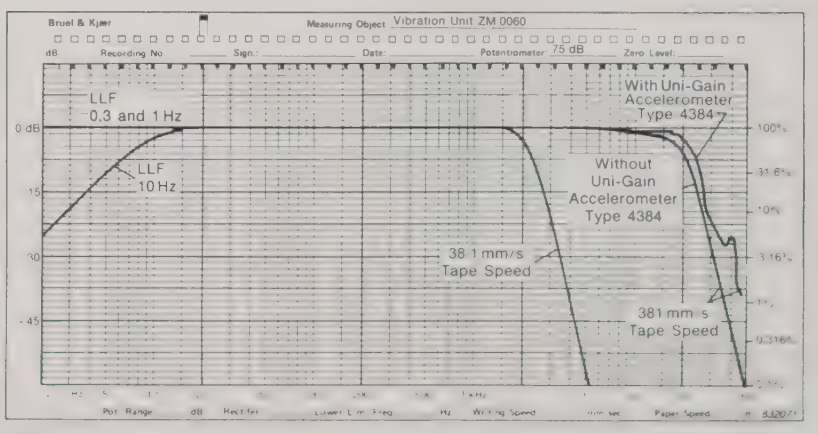


Fig. 5.1. Typical overall record-reproduce frequency response with the "Acc. – mm/s^2" mode of Vibration Unit ZM 0060

temperature fluctuations. With the B&K Uni–Gain® Accelerometers Types 4371 and 4384, as well as Types 4370 and 4381, use of the 0,3 Hz setting is normally possible on account of their low environmental sensitivity.

At high frequencies the response depends on the particular TAPE SPEED setting. For operation at 38,1 mm/s a –1 dB upper limiting frequency of 1,6 kHz is obtained, whilst at 381 mm/s the response is optimised for a –3 dB upper limiting frequency of approximately 16 kHz. Furthermore, when the B&K Uni–Gain® Accelerometers Types 4371 and 4384 are employed for recording their stud mounted response will extend the high frequency response giving a typical –3 dB upper limiting frequency of approximately 20 kHz. If other Uni–Gain or non Uni-Gain Accelerometers are utilized instead of Types 4371 and 4384 and their useful operating frequency range is less than that of the Vibration Units, then they should be mounted using a Mechanical Filter UA 0559. This is necessary to prevent their mounted resonance frequency influencing recorded measurements.

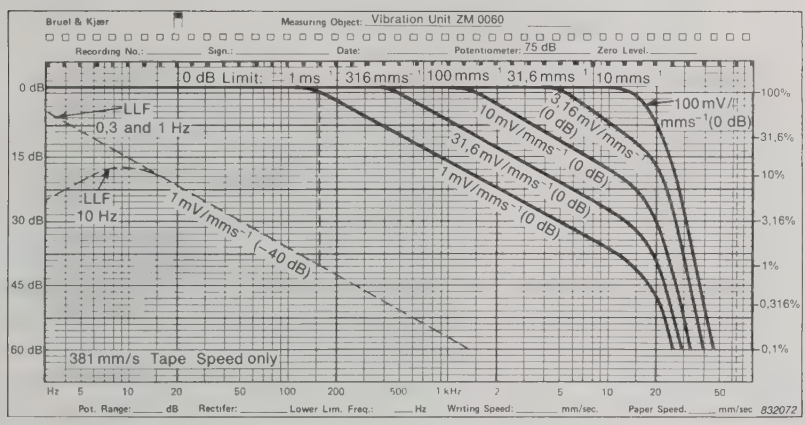


Fig. 5.2. Typical overall record-reproduce frequency response with the "Vel. – mm/s" mode of Vibration Unit ZM 0060

The overall record-reproduce response available with the "Vel" MODE SWITCH setting of the Vibration Units is shown in Fig.5.2. In this case the charge amplifier record section integrates the accelerometer signal to produce a signal proportional to vibration velocity. It is not recommended to integrate single transients or shocks with this mode as it is intended for recording of periodic signals such as vibration produced by rotating machinery (see section 5.2.3).

5.2.3. Phase Response

The maximum phase difference between any two Vibration Units ZM 0060 installed in the 7007 occurs at the upper limiting frequency of the record-reproduce range and is of the order of ±30°. This takes into account dynamic as well as static phase "errors" due to flutter, tape skew and recording tape tolerances etc. Static errors due to head alignment are negligible, as the record and reproduce heads of the Recorder are optically aligned to within ±1 minute of arc. Adjustment of the head alignment by the user is not recommended, as this requires the use of special equipment.

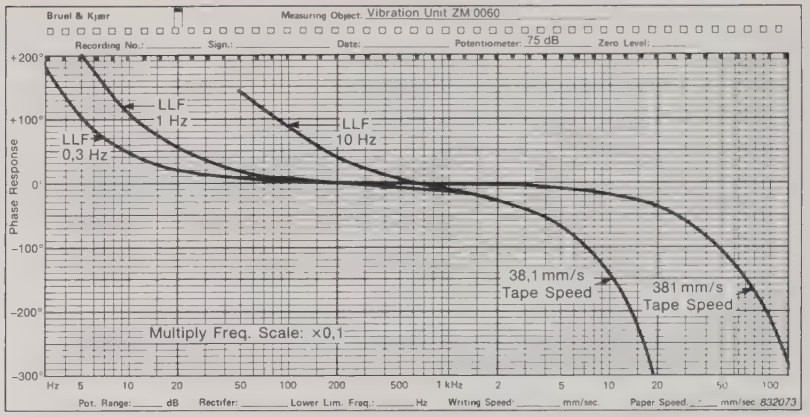


Fig. 5.3. Typical overall phase response with the "Acc. – mm/s^2" mode of Vibration Unit ZM 0060

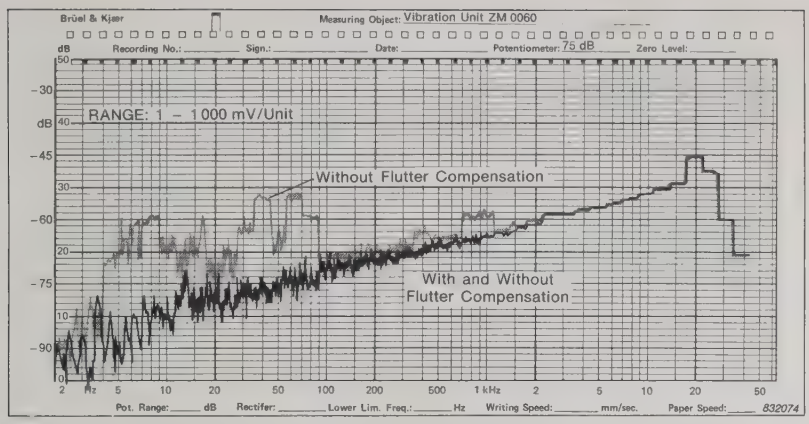
In Fig. 5.3. is shown the typical overall phase response of the Vibration Unit. The response curves were measured with the "Record"-"Stand By" mode selected, however they may also be considered representative of the "Record"-"Drive" mode. As far as recording and reproduction of periodic signals are concerned, they have no affect on measurement of RMS levels. However, with signals containing frequency components less than three times the low frequency limit or greater than one tenth of the high frequency limit of the record-reproduce range they can distort the signal waveform preventing accurate measurement of Peak levels. Consequently for recording of complex signals such as mechanical transients and shocks the use of the "Acc" MODE and "381 mm/s" TAPE SPEED settings are recommended. It is not recommended to integrate single transients or shocks with the "Vel." MODE as this is intended for recording of periodic signals such as vibration produced by rotating machinery.

5.2.4. Amplitude Stability

Tests employing the internal 1 kHz reference show that the amplitude stability of recordings made with the Vibration Units ZM 0060 is better than ±0,5 dB throughout any one spool of recording tape. Moreover, this same high stability is available even when recorded data is reproduced on another 7007 or on a 7005 or 7006 Tape Recorder. This is because all information relating to the amplitude of the input signal is carried solely by the frequency deviations in the carrier signal recorded on tape. Consequently, changes in the level of the recorded carrier, due to tape-head contact, tape storage etc., have very little effect on the accuracy of reproduce signal amplitudes with ZM 0060.

5.2.5. Noise Characteristics

Flutter and record-reproduce bandwidth are the main factors determining the inherent noise of FM recorders. With the 7007 the flutter with the 38,1 and 381 mm/s tape speed settings is low and for operation with the Vibration Units ZM 0060, enables a minimum signal-to-noise ratio of 40 dB (lin.) to be obtained (from 0,3 Hz with the Acc. Mode and from 20 Hz with the Vel. Mode). If the reproduce bandwidth is restricted as in the case when recorded signals are frequency analyzed, then the signal-to-noise ratio is effectively increased to approximately 50 dB. (See Figs. 5.4 and 5.5).


Brüel & Kjær
Measuring Object: Vibration Unit ZM 0060
Recording No.: Sign.: Date: Potentiometer: 75 dB Zero Level:
RANGE: 1 – 1 000 mV/Unit
Without Flutter Compensation
With and Without
Flutter Compensation
Pot. Range: dB Rectifer: Lower Lim. Freq.: Hz Writing Speed: mm/sec. Paper Speed:
832074

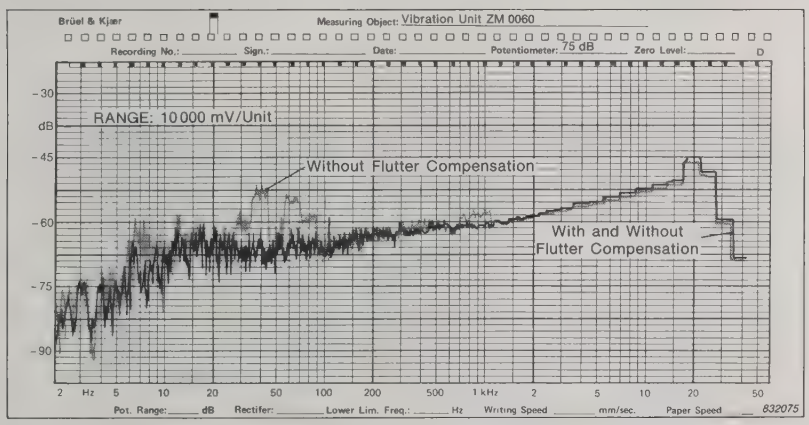

Brüel & Kjær
Measuring Object: Vibration Unit ZM 0060
Recording No.: Sign.: Date: Potentiometer: 75 dB Zero Level:
RANGE: 10 000 mV/Unit
Without Flutter Compensation
With and Without
Flutter Compensation
Pot. Range: dB Rectifer: Lower Lim. Freq.: Hz Writing Speed mm/sec. Paper Speed
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Fig. 5.4. Typical third octave frequency analyses of record-reproduce noise with the Vibration Unit ZM 0060. "Acc. – mm/s² " mode and 381 mm/s Tape Speed setting

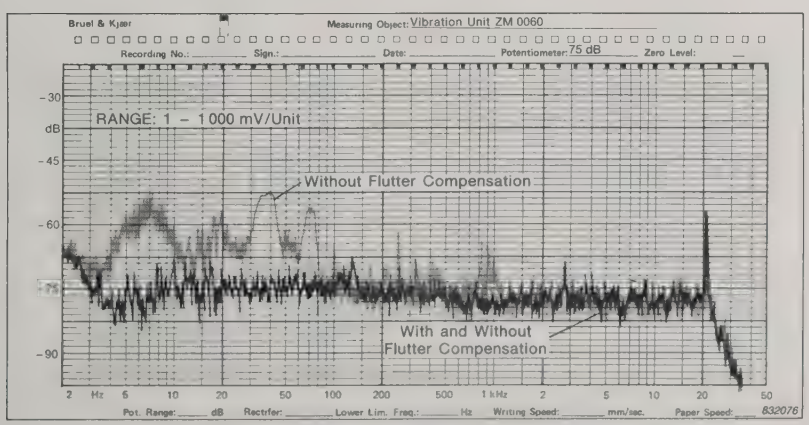

Bruel & Kjaer
Measuring Object: Vibration Unit ZM 0060
Recording No.: Sign.: Date: Potentiometer: 75 dB Zero Level:
RANGE: 1 – 1 000 mV/Unit
Without Flutter Compensation
With and Without
Flutter Compensation
Pot. Range: dB Rectifer: Lower Lim. Freq.: Hz Writing Speed: mm/sec. Paper Speed:
832076

Fig. 5.5. Typical 10 Hz constant bandwidth analyses of record-reproduce noise with the Vibration Unit ZM 0060. "Acc. – mm/s² " mode and 381 mm/s Tape Speed setting. (Continued overleaf)

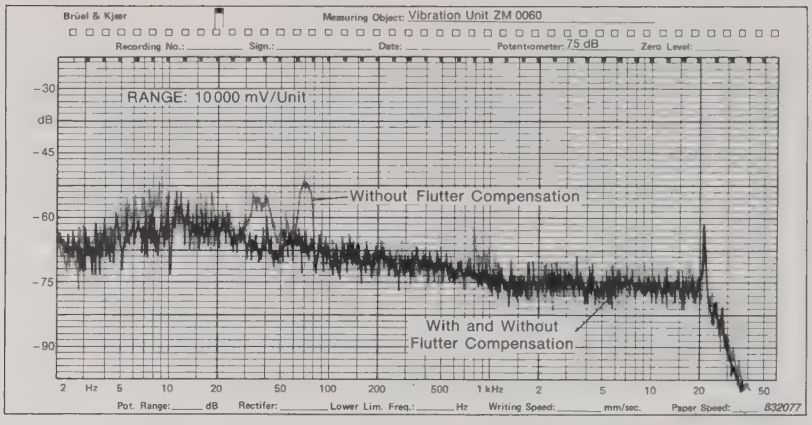


Fig. 5.5.(Cont.) Typical 10 Hz constant bandwidth analyses of record-reproduce noise with the Vibration Unit ZM 0060. "Acc. – mm/s^2" mode and 381 mm/s Tape Speed setting

Another factor influencing the signal-to-noise ratio of the Vibration Units is capacitive loading of their charge amplifier input. Normally this is only of importance when long connection cables are used for coupling Accelerometers. The signal-to-noise ratios

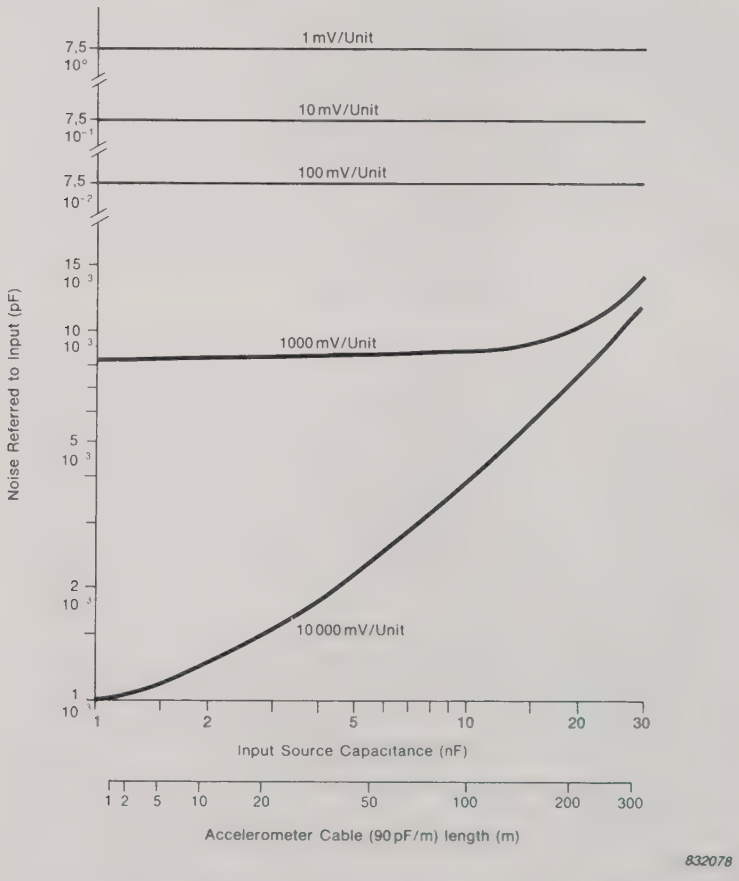


Fig. 5.6. Broadband (2 Hz to 20 kHz) noise with the Vibration Unit ZM 0060 as a function of input source capacitance. "Acc. – mm/s^{-2}" mode and 381 mm/s Tape Speed setting

specified above are applicable for an accelerometer plus 1,2 metre of cable having a combined capacitance of approximately 1,2 nF. With higher values of input source capacitance the noise level is increased as indicated in Fig.5.6. From this it can be seen that care must be excerised when using long input cables with the two most sensitive (1 000 and 10 000 mV/Unit) RANGE settings of the Vibration Unit.

To a certain extent the above reduction in signal-to noise may be counteracted by restricting the reproduce bandwidth as outlined above. However, two other means of effectively increasing the signal-to-noise ratio are with the FM Flutter Compensation mode and optional Two Channel Compander Unit ZM 0054. Operation with the former is described in section 4.7 and is useful for correcting reproduce signal amplitudes and noise for recorded flutter components. As indicated in Fig. 5.7., the effect of recorded flutter components introduced by external movement and vibration of the Recorder is reduced by as much as 35 dB at frequencies up to 500 Hz. However, as far as inherent flutter is concerned, flutter compensation has very little effect on reproduce noise.

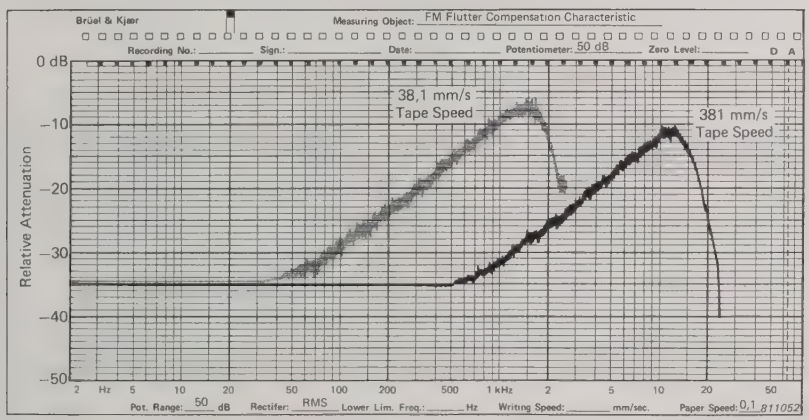


Fig. 5.7. Typical FM Flutter Compensation characteristic showing effective attenuation of flutter related noise due to external movement and vibration of the 7007

Operation of the Vibration Units with the Two Channel Compander, enables non stationary acoustic and voltage signals with a dynamic range of over 70 dB Lin. to be recorded and reproduced. This is of benefit where broad band reproduction and measurement of recorded signals is of interest. However, where frequency analysis of companded signals is involved, the actual signal-to-noise ratio is the same as that when using the Vibration Units alone. For further information on the Compander, see sections 4.5 and 5.3.

5.3. TWO CHANNEL COMPANDER UNIT ZM 0054

For recording the Compander serves as a compressor which automatically regulates the input gain in accordance the average level of the incoming signal. Signals with level below the "0 dB" nominal record level are amplified, whilst those with level above the "0 dB" nominal record level are attenuated. With non stationary types of signal (ie., those of changing level), this has the effect of compressing the signal level variations so as to suit the signal to noise ratio of the Vibration Units. See Fig. 5.8.

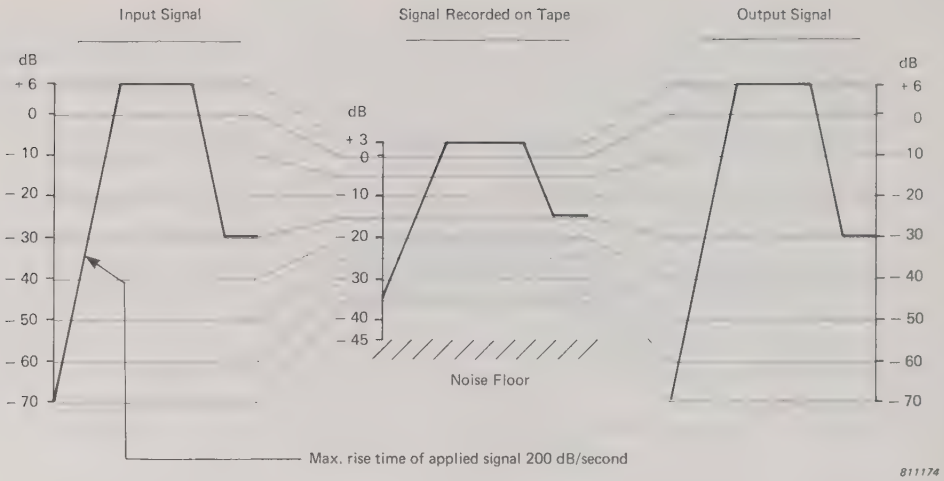


Fig. 5.8. Schematic illustrating the overall function of the Two Channel Compander Unit ZM 0054.

On playback, the Compander operates in reverse (ie. amplifies signals above the "0 dB" nominal reproduce level and attenuates those below) so as to reinstate the compressed signal in correct proportion to the original signal. The overall result is that non stationary signals may be recorded and reproduced which have a dynamic range greater than the actual signal to noise ratio of the Recorder. In the case of ZM 0054 which operates with a fixed compression and expansion ratio of 2:1 and 1:2 respectively, signals with dynamic range of over 70 dB lin. may be handled. The maximum rate of automatic gain regulation is 200 dB/s and is obtained with the COMPANDER MODE switch set to "Normal". With the "Slow" mode the maximum rate is 20 dB/s and is intended for when different tape speed settings are employed for time and frequency transformation of signals. See section 4.5.3.

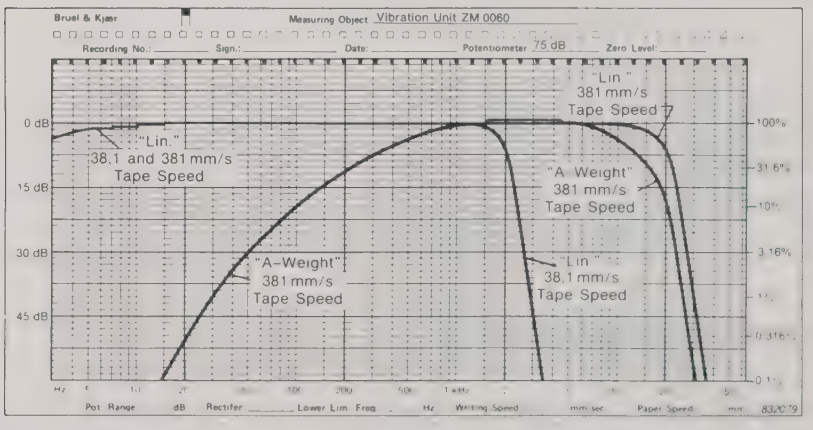


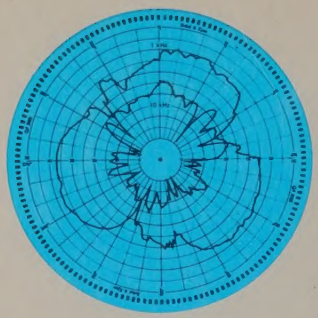
Fig. 5.9. Typical overall record-reproduce frequency response available with the Vibration Units ZM 0060 when employed with the Two Channel Compander Unit ZM 0054

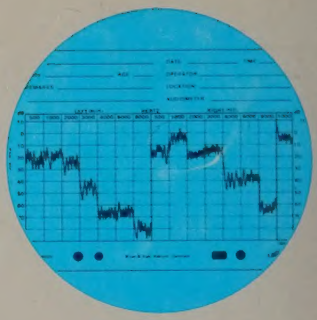
The overall frequency response obtained when using the Compander Unit ZM 0054 for automatic gain regulation with the Vibration Units ZM 0060, is shown in Fig. 5.9. Because of automatic gain regulation, the dB tolerance on the the upper limiting frequency of the record-reproduce response is twice that obtained when using a Vibration Units without the Compander in circuit. At low frequencies, however, it is the frequency characteristics of the AC input coupling networks of the Compander which determine the response.

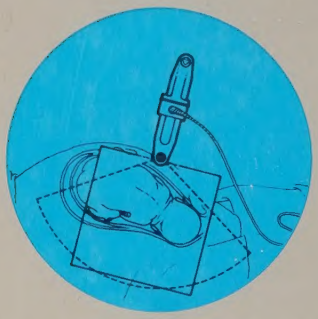
It should be noted that automatic gain regulation has no effect on the level of the individual frequency components making up a signal. As a result the maximum dynamic range available for frequency analysis of companded data is no greater than that obtained using the Vibration Units without the Compander in circuit (see section 5.2.5). Despite this, however, the Compander is of important help in ensuring correct recording of very low signal levels for analysis. For example, signals with maximum level low as 30 dB below the 0 dB nominal record level may be handled, enabling a signal-to-noise ratio of 50 dB to be obtained when narrow band frequency analysis is carried out. Without the Compander in circuit, recording of signals 30 dB below the nominal record would give analysis signal-to-noise ratio of approximately 25 dB.

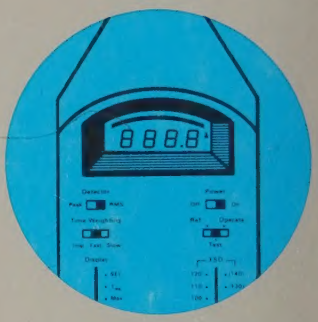
6. SERVICE AND REPAIR

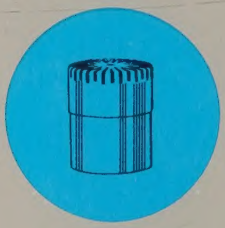
The 7007 is designed and constructed to provide the user with many years of reliable operation. However, should a fault occur which impairs the correct function of the Recorder, then its plug-in Battery Pack should be removed and all external power sources disconnected, so as to prevent the risk of further damage. For repair consult the separate Service Instruction Manual available for the 7007, or contact your local B & K service representative. Under no circumstances should repair be attempted by persons not qualified in the service of electronic measuring instrumentation.

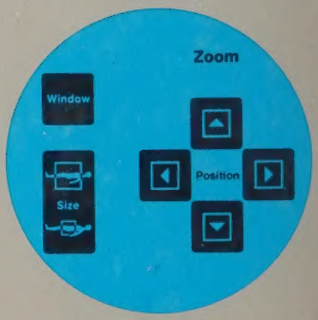


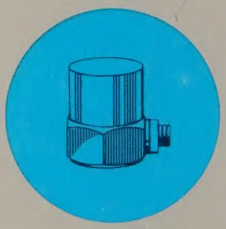


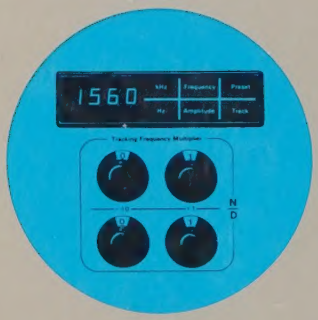


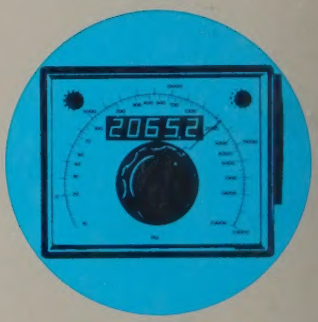


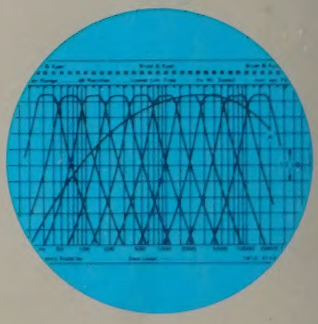












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